MANAGING KNOWLEDGE FLOWS WITHIN AND ACROSS THE BOUNDARIES OF THE MULTINATIONAL CORPORATION

AN EXPLORATORY CASE STUDY OF A MULTINATIONAL WEIGHING, MEASUREMENT AND AUTOMATION TECHNOLOGY PROVIDER

by

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Abstract

The multinational corporation (MNC) to a large extent, determines its sustainable economic success through the effective management of knowledge flows within and across its boundaries.

Based on the business network theory, the thesis applies a micro-perspective by drawing on an exploratory case study, which examines how a German-headquartered technology provider manages knowledge flows, which are reversed from its subsidiaries, and how these subsidiaries create their own knowledge depending on the specific external environments that they develop. The research interest was approached and operationalised by collecting and analysing qualitative data at two levels of analysis (these being at headquarters and subsidiary level).

Key results that emerged from the case study indicate that **firstly**, the MNC manages reverse knowledge flows in close relation with the ´technology differentiation` approach that the MNC developed as a response to increasing competitive pressures that it had faced in the 1990s. **Secondly**, the results suggest that the dynamics of economies, the case study especially focused on China in this respect, have an impact on product development. **Thirdly**, the results indicate that in addition to the external environment that subsidiaries develop, the senior local management of the subsidiaries plays an important role in motivating the employees to create new knowledge and learning capabilities and in discussing drivers of this motivation with the headquarters' management.

Key words: Reverse Knowledge Flows, Business Network Theory, Knowledge Management, Multinational Corporations, Subsidiary

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1. INTRODUCTION

This first chapter gives an overview of the overall research purpose of the thesis by revealing why several aspects in respect of the selected broad subject of knowledge management (KM), in the context of a multinational corporation (MNC), are relevant for exploration in depth. The chapter opens with the presentation of the main research question; the remaining paragraphs review how the research question emerges from, and contributes to, contemporary, practical and theoretical debates on the subject. Applying a micro-perspective, the thesis draws on an exploratory case study of an MNC. The chapter concludes with a definition of research objectives set for the two levels of analysis, the headquarters and subsidiary level, and sets out the structure of the remainder of the thesis.

1.1 The research question

The aim of the thesis is to explore the following research question:

> *How are reverse knowledge flows from foreign MNC subsidiaries, hereafter subsidiaries, managed by the MNC headquarters, hereafter headquarters, of a German-based MNC and how is the knowledge that is reversed from the subsidiaries created within their local contexts through knowledge sharing between the subsidiaries and their external environments?*

1.2 The overall research purpose

Based on the business network theory of the MNC, the overall research purpose of the thesis is to advance the state of our theoretical understanding of how reverse knowledge flows sent from subsidiaries to the headquarters of an MNC are managed by the headquarters, and how the knowledge that is reversed from the subsidiaries is created within their local contexts through knowledge sharing between the subsidiaries and their external environment.

By applying this micro-perspective, the thesis draws on an exploratory case study, hereafter, the case study, of a German-headquartered multinational weighing, measurement and automation provider. This single case study encompasses four separate sub case studies, which are conducted within this same MNC: one sub case study is conducted at headquarters level, and three sub case studies at subsidiary level.

Although these four sub case studies encompass two focal points of research according to the main research question and two different levels of analysis, there is a strong link between the one sub case study that is conducted at headquarters level and the three sub case studies that are conducted at subsidiary level. The link is their relationship in respect of intra-corporate knowledge flows. It is the central aim of the thesis to analyse this relationship in-depth, and thereby to provide an exploration of the main research question.

1.3 The contribution of the thesis

On the basis of distinct aspects that are highlighted in boxes within the following paragraphs, as well as identified gaps within the business and management literature, hereafter the literature, which are briefly introduced in the paragraphs below each respective box, the following paragraphs review the way in which the thesis constitutes a valuable contribution to contemporary, practical and theoretical debates on the subject.

1.3.1 The importance of knowledge at firm level

Box 1: *The key resource knowledge*

For some time now, knowledge has been identified as a resource that plays a central role in the management of a firm because it is regarded as a major determinant of a firms´ innovative capacity and its related performance and behaviour (Davila et al., 2006; Grant, 1996; Zack et al., 2009). Moreover, the resource knowledge has been described as playing a central role in the organisation of worldwide markets (Navaretti & Tarr, 2000). The case study leads to a better theoretical understanding of knowledge, its creation, its protection, as well as knowledge sharing at the firm level by discussing the ´technology differentiation´ approach that increases the firms´ exploitation of its distinct internal knowledge base, while trying to meet external market demands.

The role of knowledge, its important dimensions, and particularly its relevance for the management of a firm and across its boundaries have gained much attention from academic scholars over the last fifty years (Cantwell & Mudambi, 2004; Polanyi, 1958, 1966; von Hippel, 1988; Winter, 1987). In fact, KM itself is an activity that is hundreds of years old; Hansen et al. (1999), list the transfer of commercial expertise from one generation to the next within family businesses, the exchanges of craftsmen with their apprentices, or the sharing of experiences among workers as typical reciprocal aspects of KM which have existed for centuries.

However since the mid 1990s, knowledge has increasingly been pushed into the epicentre in business and management-related debates. Since that time, knowledge has been identified as being one of the most critical resources within a firm, while the management of

knowledge, and in particular the transformation of knowledge into innovation, especially in respect of products and services, has been declared as the most critical role in the overall management process of a firm (Davila et al., 2006; Grant, 1996; Nonaka & Takeuchi, 1995). More concretely, we have seen that the management of knowledge or particularly the creation of knowledge, along with the sharing and transferring of knowledge, have been increasingly identified as being closely related to what drives a firm´s performance and its distinct behaviour (Hitt et al., 1999, 2000; Switzer; 2008; Zack et al., 2009). In a broader sense, what underlies these propositions is the widely accepted argument that we have seen a transition from the industrial age where capital was the most valuable resource, to an age in which knowledge is increasingly perceived as the most valuable resource (Bresman et al., 1999).

What is noticeable in the broader sense of KM is that although there is much academic debate on the role of knowledge as the most important resource in a firm and the question of how it can be managed most effectively, there is little systematic study of how new knowledge is created at firm level, or where exactly knowledge resides within the firm, as well as how the process of knowledge creation and knowledge sharing might best be managed and exploited by the management of a firm (Frost & Zhou, 2005; Michailova & Nielsen, 2006; Nonaka & Toyama, 2003; Phene & Almeida, 2008). Moreover, research on how to effectively protect the resource knowledge remains in its infancy (Randeree, 2006). Today, these observations are mainly related to one of the most powerful types of firm, the MNC. The case study examines how and why a German-headquartered MNC developed its ´technology differentiation´ approach to organise its international knowledge creation, protection and sharing, by concentrating on its key competencies and by splitting some of these key competencies amongst its business network of subsidiaries. The link between the ´technology differentiation´ approach, and the management of knowledge, particularly reverse

knowledge flows in the MNC, constitutes a key theoretical insight. Chapter five will outline this approach in depth.

1.3.2 Reverse knowledge flows in an MNC

Box 2: *Reverse knowledge flows*

Subsidiaries have been identified as being able, potentially, to constitute a valuable source of knowledge that can make an important contribution to the overall success of an MNC (Frost, 2001; Frost et al., 2002; Nobel & Birkinshaw, 1998; Papanastassiou & Pearce, 2008; Young & Tavares, 2004). The case study explores types of knowledge flow within the MNC and discusses why knowledge flows, related primarily to research and development (R&D) and market particularities, sent from the subsidiaries to the headquarters, are relevant for an MNC in gaining a competitive advantage. Moreover, most of the differences in the nature of reverse knowledge flows that subsidiaries send to their headquarters are identified as being related to the key competencies that the subsidiaries have. This direction of knowledge flows, reverse knowledge flows, sent from subsidiaries to the headquarters receives increased attention within the literature (Ambos et al., 2006; Hakanson & Nobel, 2000; Johansen, 2007; Yang et al., 2008).

The central task of an MNC is to manage knowledge flows, or knowledge transfers, across borders in such a way that they enable the MNC to gain a competitive advantage in an international setting (Bartlett & Ghoshal, 1989; Karaszewski 2008; Mudambi & Navarra, 2004). The theoretical concepts of knowledge flows and knowledge transfers are identified as being closely related to each other and are, in many cases, used interchangeably within the literature (Gupta & Govindarajan, 1991; Mudambi, 2002). The management of knowledge

flows does not follow a straightforward process, even when it takes place within a domestic firm and within distinct national borders, and is thus not without obstacles (Szulanski, 1996). The main reason for these obstacles arising is when managing knowledge flows deals with the tacit dimension of knowledge. What does tacit knowledge mean? A discussion of different taxonomies and dimensions of knowledge will be presented in detail in chapter two; however, the relevance of tacit knowledge must be highlighted at this point because it constitutes a major focus of the thesis.

The literature views tacit knowledge as knowledge that is intangible and not articulated (Grant, 1996). Tacit knowledge is further regarded as not being easily accessible and its particular dimension makes the knowledge at firm level extremely idiosyncratic (Malerba, 2002). The theoretical concept of tacit knowledge was originally put forward by Michael Polanyi (1958, 1966), who acknowledges that human beings can know more than their consciousness suggests. Polanyi (1958, 1966), has also transferred his observation to the level of the firm, which has led us to an understanding that the firm, given that the firm is regarded as a community of individuals who interact with each other by following particular rules and regulations, may also know more than it is conscious of, or of what the individuals who belong to the firm are conscious.

The tacit dimension of knowledge constitutes a further challenge for academic research in this area. In particular, one of the critical tasks is to identify knowledge flows that usually have a tacit dimension. Within the case study, the analytical approach adopted to overcome the elusive character of knowledge flows, is influenced by the work of Bresman et al. (1999), who suggest by referring to the theoretical concept of knowledge transfers, that in order to identify and analyse knowledge transfers, **three** questions must be asked:

Question I: What is the type of knowledge being transferred?

This question was operationalised in the case study by linking different types of knowledge according to the main functions that an MNC possesses for example: R&D, production, sales & marketing.

In the broader sense, this approach was derived from the theoretical concept of intra-corporate knowledge flows put forward by Gupta and Govindarajan (1991), who differentiate types of knowledge flows according to the following four categories:

Input processes

- Purchasing know-how
- Management systems and practices

Throughput processes

- Product designs
- Process designs
- Production know-how
- Packaging design and technology

Output processes

- Marketing know-how
- Distribution know-how
- Sales skills

External market data

- Knowledge about important customers
- Knowledge about competitors

The systematic study of different types of knowledge flows was intended to enrich the case study, and to create a more nuanced picture in respect of those types of knowledge flows that allow the MNC to gain a competitive advantage. In this respect, the case study reveals that knowledge primarily flows in relation to R&D, and market particularities sent from the subsidiaries to the headquarters are relevant to the MNC in gaining a competitive edge.

Furthermore, the case study identifies that these types of knowledge flows are also the only types of reverse knowledge flows that are sent from the subsidiaries to the headquarters, and the differences of the nature of these reverse knowledge flows are predominantly related to the key competencies that the subsidiaries possess.

Question II: What is the direction of transfer?

To study the subsidiary as a source of knowledge and innovation constitutes a relevant and relatively unexplored research avenue in itself; but this also applies to the particular research setting of the case study. To clarify the first part of this proposition, the question must be asked why the idea that the subsidiary can constitute a valuable knowledge source is a relatively new aspect within KM research.

During the last two decades, academic research that dealt with knowledge flows and its related management within the MNC, has mostly focused on forward knowledge flows sent from the headquarters of the MNC to its subsidiaries and not vice versa. In particular, a dominant theory was that domestic firms internationalise or engage in foreign direct investment (FDI) such as moving some of their activity abroad, primarily to exploit their existing knowledge base such as any specific technology that they had developed in their home economy (Hymer, 1976; Vernon, 1966), and not because they had been in search of gaining a competitive advantage through the sharing of reverse knowledge created in their foreign subsidiaries. This argument was particularly emphasised in respect to those

subsidiaries that were located outside the developed economies during that time (Hymer, 1976).

Since the 1970s there have been significant changes in the worldwide economies (Audretsch & Thurik, 2001); thus the theories that had originated in the 1970s have been fundamentally revised over the years (Birkinshaw & Hood, 1998). In an assessment of Hymer´s work (1976), on the theory of the multinational and international scholarship Dunning and Pitelis (2008), recognise his academic contribution, but suggest that in the aspect mentioned above, Hymer (1976), underestimated the role of interdependent knowledge flows and learning that takes place in the headquarters-subsidiary context and, to anticipate what will be reviewed in the following paragraph, that Hymer (1976), was further proved incorrect due to his neglect of the learning ability of developing economies, hereafter emerging economies, and their ability to become a valuable platform nurturing knowledge sources for subsidiaries (Johansen, 2007) and their ability to offer a basis for new MNCs that have emerged as strong rivals for the MNCs that are headquartered in developed economies (Economist, 2010; Ramamurti, 2009).

In this respect China is the most prominent example, where MNCs that are looking for investment opportunities, are increasingly generated on a global basis with varying types of motivation, including the drive to increase and to exploit their global competencies (Economist, 2010; Ren et al., 2010). In particular, these Chinese-headquartered MNCs are increasingly able to enhance their own global competitiveness through cost innovation, which means that they exploit the ability to offer their innovative technologies at mass-market prices on the basis of a low-labour cost advantage (Zeng & Williamson, 2007).

The following section reviews some of the principal theoretical developments that have emerged between Hymer´s work (1976), and the present day, and clarifies the second

part of the idea proposed in the paragraphs above stating that the particular research setting of the case study also constitutes a relatively unexplored research avenue.

Since the 1970s and 1980s, the number of MNCs has significantly increased worldwide and their foreign activity has become more diverse and complex (Dunning & Lundan, 2008; Nohria, 2007). Accordingly, new theories had to be explored to explain why domestic firms internationalise. Especially in the 1990s, a new aspect of knowledge flows within the MNC has started to gain attention: Cantwell (1995), was one of the first who suggested that one reason why MNCs are interested in investing in subsidiaries is to take advantage of particular knowledge held in these subsidiaries; knowledge to which the MNC had no access to before. In the same vein, it has been argued that different subsidiaries diverge in their knowledge bases because of their embeddedness in different local contexts (Nohria & Ghoshal, 1997), and therefore allow the MNC to access a wide variety of different geographically-dispersed knowledge and to share the larger knowledge base around the entire MNC.

In this respect, a growing academic interest has also emerged in subsidiaries as beginning to constitute centres of excellence within the MNC (Andersson & Forsgren, 1996; Forsgren & Pedersen, 1998; Frost et al., 2002; Moore & Birkinshaw, 1998). This new role of subsidiaries becoming valuable knowledge sources within the overall knowledge creation process of the MNC has increasingly gained interest among academic scholars, practitioners and policy makers, although research on the innovative capacity of subsidiaries and the search of the MNC for particular knowledge in their subsidiaries is limited (Phene & Almeida, 2008).

Moreover, it must be noted that, until the late 1990s, research that focused on subsidiaries as becoming valuable knowledge sources for the overall MNC, primarily focused

on subsidiaries located in developed economies such as the United States (US) (Bird & Beechler, 1995; Frost, 2001), Western Europe (Cantwell & Mudambi, 2005; Forsgren et al., 1999), and Japan (Westney, 1987). The research setting of the case study of this thesis encompasses one subsidiary that is located in a developed economy (US) besides two subsidiaries that are located in emerging economies (the Philippines and India). Moreover, the sub case study conducted at headquarters level further revealed data in reference to the Chinese subsidiary, again another subsidiary that is located in an emerging economy. To examine in what way subsidiaries that are located in emerging economies are representing new valuable knowledge sources for those MNCs, which are headquartered in developed economies, is clearly a new approach (Cui et al., 2006; Khan & Bamber, 2007; Johansen, 2007; Yang et al., 2008; Zheng, 2007). An important theoretical insight emerging from the field of research is that the high dynamics in emerging economies forces the MNC to set up production and R&D functions; the latter because only R&D employees who are located on the ground in dynamic economies understand these dynamics and are able to respond to them, in contrast to R&D employees who are located in an economy having less dynamics.

A further and exciting aspect of the case study deals with the relatively short time that it takes subsidiaries located in emerging economies to turn from knowledge recipients to senders of knowledge, a finding that surprised the headquarters' management.

Question III: What is the quality of the knowledge transfer?

Within the case study, the quality of knowledge flows, or transfers, is identified by observing how the headquarters of the MNC evaluates the quality of the knowledge flows reversed by their subsidiaries. This approach is derived from the theoretical concept of the benefits of knowledge flows proposed by Ambos et al. (2006). The case study reveals the way in which the quality of the knowledge flows that the subsidiaries reverse to the headquarters

differs. In a broader sense, the analysis of the differences in quality of knowledge flows is understood as a practical approach that agrees with the observations made by the literature where it remains unclear how MNCs with dispersed innovative activities can integrate key knowledge effectively (Frost & Zhou, 2005).

1.3.3 Subsidiaries and their external environments

Box 3: *External environments*

As reviewed in the paragraphs above, the role of subsidiaries constituting important sources to the MNC to create new knowledge and innovations is increasingly recognised within the literature. Nevertheless, the creation of knowledge in subsidiaries needs a clearer conceptualisation (Frost & Zhou, 2005; Phene & Almeida, 2008). Linked to the business network theory of the MNC, one main focus of this thesis is to shed light on how the local context, hereafter the external environment, in which a particular subsidiary is embedded, shapes the creation of knowledge within the subsidiary. Interest in the influence of the external environment on knowledge creation in subsidiaries is based on literature that posits the local context in which a MNC is embedded, and reflects the creation and sharing of knowledge within the MNC (Andersson et al., 2002; Nohria & Ghoshal, 1997). A valuable aspect that the case study reveals in this respect, is that the access to a particular external environment does not only have an impact on the way knowledge is created in the subsidiary, but also on the knowledge that the subsidiary reverses to the headquarters of the MNC. In addition to the external environment, the case study reveals the importance of the senior local management of the subsidiaries to motivate their employees to create new knowledge bases and learning capabilities, and to discuss drivers of motivation with the headquarters

Two main knowledge sources are studied in this thesis: As touched on in the paragraphs above, a particular subsidiary is conceptualised as one knowledge source from the perspective of the headquarters, and the external environment in which a particular subsidiary develops is regarded as the other knowledge source from the perspective of the subsidiary.

The following paragraphs briefly introduce how the external environment is conceptualised within this thesis.

Firms as well as MNCs are locally embedded. There are different streams of literature that deal with, and conceptualise, local embeddedness such as human and economic geography (Bathelt et al., 2004; Bathelt & Glückler, 2002; Feldman, 1994; Ivarsson & Alvstam, 2005; Malmberg & Maskel, 2002), systems and national systems of innovation (Cantwell, 1995; Nelson, 1993; Patel & Pavitt, 1994), sectoral systems of innovations (Breschi & Malerba, 1997; Geels, 2004), or external environments (Andersson & Forsgren, 1996; Andersson et al., 2001, 2002; Zanfei, 2000).

Within this thesis, local embeddeness is associated with the embeddedness of a subsidiary in a particular local context that consists of a particular business and institutional system of the economy in which it is located, as well as the external environment that it develops itself. In the broader sense, the literature conceptualises the external environment as the external side of the business network of a subsidiary and the MNC respectively, and therefore as a compliment to the internal side of the business network, which is made up of the headquarters, subsidiaries and units of the MNC (Foss & Pedersen, 2002; Zanfei, 2000). The external environment allows the subsidiary to exchange and share information and knowledge that may become an important influence within the creation of knowledge in the subsidiary.

The theory of the MNC as a business network, including the internal as well as external network (Ghoshal & Bartlett, 1990), is beyond this introduction and will be reviewed in more detail in chapter two.

In summary, the case study will focus on the following two domains:

- Micro-domain: Knowledge flows from the subsidiaries to the headquarters (and to some extent also vice versa)
- Macro-domain: Knowledge flows from external environments to the subsidiaries

Within the case study, knowledge flows from the external environment of the headquarters to the headquarters are not considered, although this research route is regarded as constituting a valuable supplement to the current thesis. The reason for excluding this domain is that the one main focus of the thesis is on the creation of knowledge at subsidiary level, and particularly on how the knowledge that is created depends on the sharing of knowledge between a particular subsidiary and its external environment. Above all, it is to focus on how subsidiaries that are located in different economies, whilst some are located in emerging economies, are able to offer a source of knowledge for a MNC, which historically, entered these contexts primarily without the intention of exploiting local knowledge. At headquarters level, the primary focus is on the sharing and exploitation of knowledge that is reversed from the subsidiaries. To focus additionally on knowledge flows from the external environment of the headquarters to the headquarters would be too comprehensive to include within this thesis, and would shift the main research focus. Nevertheless, in line with the concept of how subsidiaries create knowledge, it is acknowledged that all knowledge creation, as well as knowledge sharing, which takes place at headquarters level, is influenced by the external environment that the headquarters develop.

A key theoretical insight, which emerged from the case study, is that in addition to the impact of the external environment on the creation of knowledge in the subsidiary, the senior local management of a subsidiary plays a key role in motivating its employees to create new

knowledge bases and learning capabilities and to discussing drivers of this motivation with the headquarters.

1.3.4 The MNC and the sector of mechatronics

Box 4: *The case*

The most influential research on KM related issues is concerned with large MNCs (Nunes et al., 2008). The case study picks up on a contemporary unexplored research setting. This applies to two aspects in particular: The size as well as the high-tech sector of mechatronics in which the MNC operates; the revelation that the nature of the sector allows the MNC to apply its ´technology differentiation´ approach.

In detail, the research setting of the case study constitutes an exciting context to explore the main research question because:

Firstly, there is the aspect of the size of the MNC. The MNC describes itself as being attached to the Mittelstand which is a typical German phenomenon. The development and existence of the Mittelstand is regarded as an important driver for Germany's economic recovery following World War II; it can encompass a variety of different types of firms spanning from local retailers to global market leaders (Goeke, 2008). The MNC might be described as an international market leader while at the same time not necessarily being a large MNC. A more detailed report on the MNC incorporating the history, its key competencies and market focus, the specific culture, the structure of ownership is beyond the boundaries here. These will be presented in the following chapters in more detail.

Although studies exist that select international KM-related issues as their central theme, there are claims amongst business and management scholars that research on the management of knowledge flows in an international setting, and the internationalisation of innovation within the context of the MNC, have mostly focused exclusively on the largest MNCs (Acs & Yeung, 1999; Acs et al., 2001; Holm & Poulfelt, 2003; Nunes et al., 2008). In particular, Hutchinson and Quintas (2008), point to the most significant work on the subject; for instance, the contribution of Nonaka and Takeuchi (1995), who had focused intensively on large MNCs such as Canon, Honda and Matsushita, or Davenport and Prusak (1998), who based their observations and theories on field research carried out at Anderson Consulting, Boeing, British Petroleum, and other large MNCs.

Valkokari and Helander (2007), suggest that for firms and MNCs that are not large, knowledge and business network management can be challenging as the knowledge base is mostly located within a handful of employees. In a similar way, Nunes et al. (2008), highlight that like large MNCs, more medium-sized and small MNCs are in need of effective exploitation of their key knowledge to remain competitive, particularly because they are, in contrast to large MNCs, facing a higher risk of turnover of key employees and the subsequent consequences of knowledge loss. Therefore, to study whether the size of the MNC raises particularities that have not been identified within the research on the largest MNCs in this area will be another new aspect explored in this thesis.

Secondly, the sector in which the MNC operates provides a platform yet to be researched, in order to explore KM related issues. The MNC predominately operates in the German mechatronical sector that comprises mostly of firms and MNCs that are small or medium-sized. The German mechatronical sector counts as one of the most sustainable in the German economy; its products, together with its R&D, as well as its production processes are

regarded as some of the most innovative when compared internationally (SPECTARIS, 2009). Although the principal business focus of the firms within the German mechatronical sector is to serve the international market, the major R&D and production functions are mainly located within Germany to keep key competencies at home. Moreover, although most of the MNCs have subsidiaries, these subsidiaries have not traditionally been regarded as valuable knowledge sources, but as constituting pure knowledge recipients from the German headquarters. By this means, the rationale for their existence has been either to serve as a facilitator to enter new markets, or to reduce the relatively high cost of labour in Germany. For instance, the MNC being studied originally opened up its Chinese subsidiary to avoid high customs costs for its weighing products that had been developed and produced in Germany, by letting their Chinese employees install the top cover to complete the otherwise finished product. At that time the FDI in China had not been intended as an access point to a particular knowledge base.

The case study reveals that the ´technology differentiation´ approach is closely linked to the particularities of the sector of mechatronics. Therefore, the approach is regarded as an effective way to manage reverse knowledge flows in MNCs that operate in sectors sharing similar characteristics to the sector of mechatronics.

1.4 The research objectives

To provide a clear structure for the thesis, and in order to systematically approach the main research purpose, two sets of research objectives are formulated whereby one set focuses on the headquarters level and one set focuses on the subsidiary level. The objectives set for the subsidiary level are the same for each sub case study that is conducted in the different subsidiaries. This approach will allow for better comparability of the various subsidiaries.

1.4.1 Research objectives at headquarters level

At headquarters level, the aim is to study the ways the headquarters management manages reverse knowledge flows from its subsidiaries, and analysing the obstacles which occur within this management process. In particular, it is key to assess why particular types of knowledge, reversed from the subsidiaries, are regarded as important by the headquarters' management to serve as a source for achieving a competitive advantage in respect of the overall MNC.

In more detail, the following set of research objectives is applied to the headquarters level:

- To explore different types of knowledge that are reversed from the subsidiaries and to analyse how subsidiaries differ in regard to the nature of the types of knowledge that they reverse to the headquarters
- To explore in what way the access to reverse knowledge flows from its subsidiaries was the reason for the headquarters´ management to set up, or to acquire, the various subsidiaries
- To analyse and assess different approaches applied by the headquarters´ management to manage reverse knowledge flows from its different subsidiaries and to examine in what way and why the headquarters´ management faces obstacles when managing and exploiting reverse knowledge flows from its subsidiaries

1.4.2 Research objectives at subsidiary level

At subsidiary level, it is the aim of the thesis to examine how a particular subsidiary is embedded within the business network. In particular, the central focus is to explore what types of reverse knowledge flows a particular subsidiary sends to the headquarters. Moreover, it will be especially important to study in what way a particular subsidiary perceives the headquarters as a facilitator to develop new knowledge bases and learning capabilities, as well

as to reverse its knowledge to the headquarters. A second aim of the thesis is to shed light on the ways a particular subsidiary develops its unique external environment, and how this external environment shapes the knowledge creation process in this particular subsidiary.

In more detail, the following set of research objectives is applied to the subsidiary level:

- To analyse when and why a particular subsidiary regards the headquarters as interested in its specific knowledge base and to study in what way a particular subsidiary feels motivated by the headquarters to create new knowledge bases and learning capabilities
- To explore potential obstacles that a particular subsidiary may face when sharing knowledge with the headquarters and to explore in what way a particular subsidiary is willing to reverse its key knowledge to the headquarters as well as to analyse potential risks that a particular subsidiary might face when it reverses its key knowledge to the headquarters
- To identify who, or what, belongs to the external environment of a particular subsidiary and to analyse how access to a specific external environment influences the way in which knowledge is created within a particular subsidiary, as well as reversed by a particular subsidiary to the headquarters and to explore why, besides the influence of its external environment, the employees of a particular subsidiary regard their subsidiary as offering a valuable knowledge base to the headquarters.

1.5 Structure of the remainder of the thesis

The thesis is composed of six chapters. Following this introductory chapter, the aim of chapter two is to present how the main research question emerges from the existing literature, and the different streams of literature that are studied to frame the research question. Chapter

two is divided into two parts: PART I presents a model underlying the theoretical foundations of the thesis while systematically reviewing the important practical and theoretical issues related to the particular areas of research interest. PART II presents a number of distinct gaps in the literature. Based on these gaps, research questions are formulated that build the basis for the case study.

Chapter three reviews the methodology adopted.

The fourth chapter identifies specific aspects related to the sector of mechatronics.

The fifth chapter is the heart of the thesis: This chapter presents a review of the results of the case study and discusses the principal theoretical insights that emerge from the case study. The chapter is roughly divided into two parts: PART I is primarily concerned with the presentation and discussion of the results in respect of the sub case study at headquarters level, PART II deals primarily with the presentation and discussion of the results in respect of the sub case studies at subsidiary level.

The final chapter presents the conclusion of the thesis. In particular, it discusses how the purpose of the thesis has been met and briefly reviews the limitations of the thesis. Moreover, chapter six provides some suggestions for future avenues of research on the subject.

2. LITERATURE REVIEW

The following chapter discusses the relevant literature and literature gaps in respect of the main research question of this thesis. In particular, the chapter identifies how the main research question emerges from the existing literature and the various streams of literature studied to frame the research question. The chapter consists of two main parts: PART I introduces the reader to the foundations of this thesis. Based on existing literature gaps,
PART II presents research questions set for the case study at headquarters and at subsidiary levels.

PART I

2.1 Foundations of the thesis

To facilitate understanding of the foundations of the thesis, the following model (figure 1) of the MNC and its related internal and external links was developed. On the basis of the main focus of this thesis, these internal and external links primarily represent channels through which knowledge flows, knowledge is reversed and knowledge is shared.

The model shows the headquarters as the largest circle centred within a grey shaded circle and located at the centre of a larger circle; it is joined to its various external partners who are represented by the smaller circles within the grey shaded circle. The external partners

are conceptualised as the external environment of the headquarters. In addition, the headquarters is conceptualised as being simultaneously locally embedded in a particular business, and institutional system, of its home economy, which is represented as the grey shaded circle.

The model shows the links from the headquarters to three selected subsidiaries. The subsidiaries are located in different economies and have other links to external partners who are represented by the smaller circles and ovals that also constitute the external environments of the subsidiaries. Furthermore, the subsidiaries are also locally embedded in particular business and institutional systems of their home economies, these are represented by the bigger circles that are shaded in green, or orange or pink. Making use of the different colours of the business and institutional systems of the economies where the headquarters and its various subsidiaries are locally embedded, demonstrates that all of these economies are unique and thus not congruent. For instance, they differ in business policies and practices, culture or educational institutions.

In essence, what underlies this model is the combination of the theory of the MNC and the theory of the firm as a business network. To conceptualise the MNC as a business network, although attaching different terms to it, has increasingly gained acceptance in all available literature (Andersson et al., 2007; Forsgren, 2008; Ghoshal & Bartlett, 1990), and proved especially useful when exploring the context of internal and external knowledge flows (Foss & Pedersen, 2002; Frost et al., 2002; Gupta & Govindarajan, 2000). The paragraphs below review the business network theory of the MNC in more detail. Furthermore, they identify how knowledge as a resource has gained increasing importance among business and management scholars, and how it led to new ways of modelling a firm as well as the MNC. The major focus of this thesis rests upon a distinct perception: knowledge flows within and

across the boundaries of the MNC. Therefore, the following paragraphs further review what knowledge is, how knowledge can potentially flow and the different forms of knowledge flows that exist in the context of the MNC. Last but not least, linked to the business network theory of the MNC, external environments and the business and institutional systems in which the headquarters and its various subsidiaries are locally embedded are defined, along with an explanation of how they will be studied within the case study.

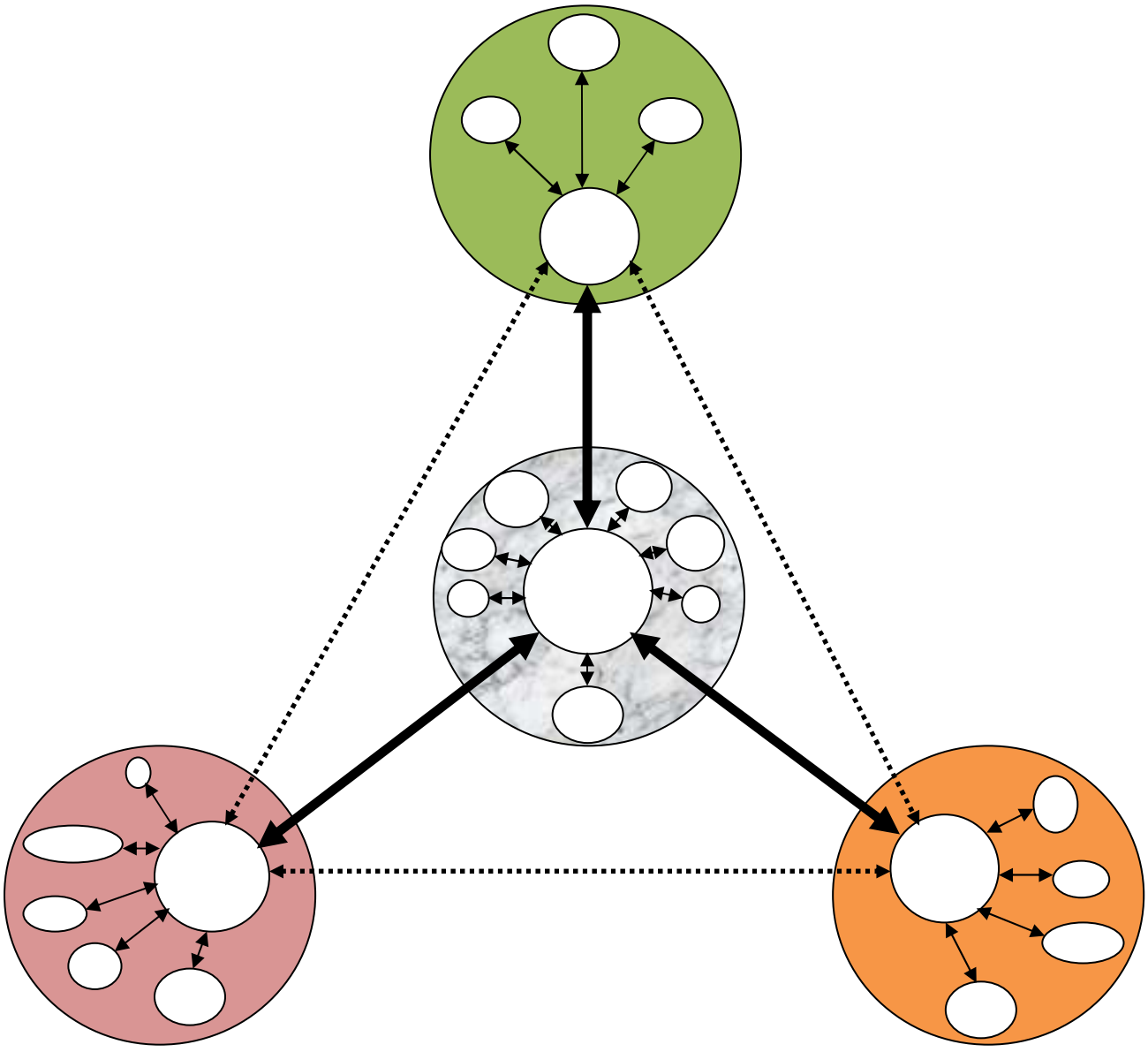

Figure 1: Model of the multinational corporation (MNC) and its main knowledge sources and knowledge flows

2.1.1 Competition, MNCs and the business network theory

There is wide acceptance among business and management scholars that over recent decades, competition in general for a firm as well as for a MNC has changed significantly. Three important changes in competition are presented below. Additionally, the following paragraphs review how these changes in competition may be linked to the development of the business network theory of the MNC, and to distinct characteristics of how MNCs create and share their key knowledge in order to achieve a competitive advantage.

2.1.1.1 Three critical changes in competition

One significant difference in competition deals with the fact that the major character of competition amongst firms as well as MNCs has radically changed. Within available literature, it is widely accepted that competition, whilst once being primarily concerned with the creation of physical assets, is more concerned nowadays with the intelligent allocation and exploitation of intellectual resources; knowledge and ideas that are then transformed into new technologies, products and services (Drucker, 1999; Dunning, 2000; Porter, 1995; Prahalad & Hamel, 1990; Subramaniam & Venkatraman, 2001; Toffler, 1990). As a consequence, knowledge and innovation management have become two of the central tasks for the management of any business or MNC.

A further noteworthy change in competition has been experienced since the 1990s. Since that time most firms and MNCs have faced a growing intensity in competition. This intensity has manifested either from a major increase in total outward stock of foreign investment, which showed a six-fold increase in 2005 compared to 1990, or the significant increase in numbers of new MNCs (especially in emerging economies) (Dunning & Lundan, 2008). In general terms, Dunning (2000), suggests that one explanation for this increased intensity of competition is related to the increase in corporate venture and alliances amongst

principal wealth-creating organisations. A further explanation deals with the ongoing economic liberalisation in many emerging economies.

This growing intensity also includes certain increasing dynamics in competition. Increasing dynamics in competition become, for instance, manifest in the speed at which MNCs gain substantial global market shares in their sectors (Dunning & Lundan, 2008; Ramamurti, 2009). Nohria (2007), highlights that the Korean-headquartered MNC LG, once a small synthetic material manufacturer, has rapidly transformed into one of the most successful producers of flat-screen televisions. Samsung, another Korean-based MNC, has similarly transformed into a global player within the electronics sector. Both MNCs have succeeded in catching up with their Japanese competitors who had successfully overtaken their European and American competitors in the 1970s and 1980s. However, in comparison to their Japanese predecessors, the Korean MNCs have taken far less time to turn into successful global players.

2.1.1.2 Changes in competition and models of the firm and the MNC

All three changes in competition may be linked to specific ways of modelling a firm and the MNC to new perspectives of how they create and share their key knowledge. Looking initially at the firm, these changes in competition can become linked to the widely accepted knowledge-based theory of the firm (Grant, 1996), as is identified in more detail under 2.1.2. By the same token, the changes in competition also constitute a major reason why new theoretical approaches explain why firms begin to engage in FDI, or even why MNCs exist at all and how they succeed (Birkinshaw & Hood, 1998). For instance, in the early days of research on the internationalisation of a domestic firm, it was suggested that internationalising firms consider their foreign subsidiaries, or units, solely on the basis of exploiting their existing firm-specific advantage, as in their overseas technology (Hymer, 1960; Vernon,

1966). In particular, the headquarters was conceptualised as having a hierarchical and didactic relationship with its various subsidiaries and units, having no intention either of integrating them on a wider international level in a network, or even of learning from them.

Perlmutter (1965), was one of the first researchers who doubted that only one model could explain the variety of internationalising firms, or could explain the existence of MNCs in general. He introduced his often cited distinction between ethnocentric, polycentric and geocentric MNCs. A discussion of the ethnocentric and polycentric models of the MNC is beyond the content of this thesis. The focus here is, in particular, on Perlmutter´s (1965), geocentric model of the MNC, which has developed as the basis and catalyst for various academic discussions on the theoretical concept of the MNC as a business network. The essence of the geocentric model of the MNC, introduced by Perlmutter (1965), is that by its diverse range of subsidiaries and units in several different economies, the MNC is able to exploit various advantages that include economy specific advantages, as well as subsidiary or unit specific advantages. In particular, Perlmutter (1965), regarded two distinct characteristics of the geocentric model of the MNC as new and important. On one side, he pointed to the interdependence of the different subsidiaries and units, and on the other side he highlighted the systemic character of the exploitation of competitive advantage.

2.1.1.3 The business network theory of the MNC and the role of knowledge

Rooted in the geocentric model of the MNC, the business network theory of the MNC developed. The essence of this theory of the MNC in terms of its structure is that the MNC is regarded as a business network, made up on the internal side, of the headquarters and different subsidiaries as well as units that are geographically spread among different economies, and their relationships through which transactions take place that are related to capital flows, product flows and knowledge flows. On the external side of diverse organisations such as

customers and suppliers and their relationships, which the headquarters, subsidiaries and units have developed in order to share knowledge and to learn (Andersson et al., 2007; Bartlett & Ghoshal, 1989; Forsgren, 2008; Hedlund, 1986; Rugman & Verbeke, 2001; Teece, 1977). By applying this theoretical concept to an empirical context, the key research interest is on the lateral relationships that are found within the MNC, theorising that the MNC benefits from transferring and sharing key resources and competencies that develop in the headquarters, and in its subsidiaries and units, and thereby being dependent on their relationships with other organisations (O´Donnell, 2000). Accordingly, the management of knowledge and innovation is, therefore, not necessarily restricted to geographically specific parts of the MNC (Holm et al., 1995). In response to the intensity and dynamic of competition, and in order to stay internationally competitive, MNCs are required to constantly create new knowledge that can flow in and out of geographically-dispersed subsidiaries, units and other related organisations to yield benefits in technical innovation, product innovation and strategic or organisational innovation (Bartlett & Ghoshal, 1989; Cantwell & Piscitello, 2000, Nonaka, 1994). It is important to note that since the beginning of this century, these geographically-dispersed knowledge-creating subsidiaries, units and organisations are increasingly found located not just in developed economies but also in some emerging economies (Cui et al., 2006; Yang & Mudambi, 2008). Above all, it seems that MNCs are increasingly becoming metanational. The theoretical concept of the ´metanational company´ was first introduced by Doz et al. (2001, p.5), who suggested that ´[m]etanational companies do not draw their competitive advantage from their home country, nor even from a set of national subsidiaries. Metanationals view the world as a global canvas dotted with pockets of technology, market intelligence and capabilities. By sensing and mobilizing scattered knowledge, they are able to innovate more effectively than their rivals.'

To sum up, the paragraphs above highlight that three distinct changes in competition may be linked to the development of the business network theory of the MNC, which is rooted in the geocentric model of the MNC developed by Perlmutter (1965), in the 1960s. In particular, this theory has proved to be valuable when studying MNCs because it allows for discussions based on its main characteristic, showing that the MNC benefits from being able to transfer and share key resources and competencies that have been developed in different subsidiaries, units and related organisations, and how and where the MNC creates and shares its key knowledge to become, and remain, internationally competitive.

2.1.2 The knowledge-based theory of the firm

The theoretical conceptualisation that the MNC has to leverage its process of knowledge creation and sharing over its entire business network of dispersed subsidiaries and units and other organisations, and to integrate them successfully to stay globally competitive, is to some extent anchored in, and developed from, the knowledge-based theory of the firm, a further foundation within this thesis. The knowledge-based theory of the firm was touched on by strategy scholars in the 1960s (Chander, 1962), by evolutionary economists in the 1980s (Nelson & Winter, 1982) and was subsequently refined by strategy scholars in the 1990s (Grant, 1996; Prahalad & Hamel, 1994).

2.1.2.1 The resource-based theory of the firm

The origin of the knowledge-based theory is found in the resource-based theory of the firm, which was proposed by Edith Penrose in 1959, who described a firm as a set of different resources and conceptualised them as being heterogeneous. Each firm was, in this respect, considered to be unique because of its exclusive mix of resources. Mahoney and Pandian (1992), identify that resources in general, and with particular reference to Penrose, may be

classified according to various general tangible and intangible categories, such as equipment and land, labour and skills. The resource-based theory was further expanded by other authors (Amit & Schoemaker, 1993; Barney, 1986; Dierickx & Cool, 1989; Nelson & Winter, 1982). The resource-based theory suggests that firms can only gain a competitive advantage by the successful control of their resources. In particular, these resources might be either tangible or intangible; however, what is critical is that they must have value, they must be rare and they must not be easy to imitate or substitute (Barney, 1991). The resource-based theory has allowed for numerous new propositions about the firm. Firstly Wernerfelt (1984; 1997), suggests research into firms in respect of their resources that leads to different insights in contrast to the traditional product perspective. This perspective only considers total resources; thus neglecting the opportunity to benefit from high returns that depend on a split of the collective of resources into individual resources; secondly, allows for the identification of those resources that yield high profits; thirdly, requires the firm to balance any exploitation of existing resources, and the development of new resources; fourthly, it sees an acquisition of one firm by another as an acquisition of a distinct collection of resources.

The resource-based theory of the firm has been criticised for neglecting the dynamism that the firm typically faces when building its own resources. This dynamism exists directly because of the exchanges between the firm and its environment (Nonaka & Toyama, 2003) – an emerging concept that was later picked up by scholars applying a resource-dependency theory (Fredericks, 2005), as well as an ambidexterity perspective (Rothaermel and Alexandre, 2009).

2.1.2.2 From the resource-based theory to the knowledge-based theory of the firm

The resource-based theory was refined by Teece et al. in 1997. They highlight that resources such as skills, or other forms of distinctive competencies, do not only have to be unique, or

difficult to transfer and imitate, but they also have to be constantly renewed in order to reflect, and adapt to, the ongoing changes in competition. Furthermore, Teece et al. (1997, p. 516), suggest that the firm must develop dynamic capabilities that they define as ´…..the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments´. The theoretical concept of dynamic capabilities differentiates itself from the resource-based theory, not only by referring to the internal resources but also to the external resources, as the principal ingredients for a firm to achieve its competitive advantage.

When Teece et al. (1997), introduced their theoretical concept of dynamic capabilities, knowledge was, in the same vein, considered to be the most important resource strategically for the firm and a key ingredient for the development of its organisational capability; this argument that has led to the knowledge-based theory of the firm.

Grant (1996), proposed that the knowledge-based theory of a firm suggests that its primary role is to transfer and share knowledge under the three assumptions that, first of all: knowledge is the critical input in all processes related to production; secondly, knowledge resides within an individual in a specialised form; and thirdly, production requires a mix of several different types of specialised knowledge. The essence of the knowledge-based theory described by Grant (1996), is related to the theoretical concept of dynamic capabilities put forward by Teece et al. (1997), as cited above. However, in line with the resource-based theory of the firm, Grant (1996), focuses mainly on the importance of internal resources for the firm's knowledge creation process inside the firm. Grant (1996, p. 377), states that the creation of firm-specific capabilities results from the integration of specialist knowledge to carry out a productive task and defines it as ´… a firm's ability to perform a productive task

repeatedly, which relates directly or indirectly to a firm's capacity for creating value through effecting the transformation from inputs into outputs´.

Linked to the knowledge-based theory of a firm but applying an evolutionary view of it, Kogut and Zander (1992), argue that firms exist because they are more efficient at creating and sharing knowledge than are markets. The origin of this argument may be traced back to influential comments made by Coase (1937), in his article on the nature of a firm. In his article, he argued that because of the relatively high transaction cost of market exchange, it would seem less costly to organise production within a firm than on the markets. And arguments made by Williamson (1975), proposed that a firm is superior to markets when organising production because it does not rely solely on the formal contracts that are used by markets; formal contracts are typically incomplete whereas informal contracts, which are not enforced by the courts, are often better suited than static formal contracts. In particular, Kogut and Zander (1992), conceptualise the firm as a social community, which enables the conversion of social expertise into products, and services, through distinct principles. Following the arguments put forward by Coase (1937), and Williamson (1975), their theory is especially intended to be understood as an antithesis of earlier transaction cost theories that have described a firm as a package of contracts. In other words, it proposes that the firm knows more than is revealed within its contracts. This theory is further based on the premise that the quantity of knowledge that resides in a particular firm is both tacit and social. Moreover, firm-specific knowledge is understood, because it is generated in a specific social setting and is neither separable from a particular social setting, nor found in one specific individual, and only accumulates through experience, as largely path-dependent (Foss, 1996). All of these features and specific dimensions of knowledge make knowledge extremely

difficult to share amongst different units, and impose a major challenge for the management of any business.

In response to Kogut and Zander´s (1992) theory of the reason why firms exist, Gupta and Govindarajan (2000), state that even though firms exist because they have a greater understanding than do markets about how to efficiently share knowledge among different units, it does not mean that they perform this knowledge sharing efficiently and effectively on a regular basis. Moreover, Yamin (2002), highlights that if the theoretical concept of the firm as a social community is applied to the MNC, the processes of the creation as well as the sharing of knowledge are likely to be especially problematic, due to the various social arrangements across the different national settings in which the MNC is typically embedded.

To conclude, the knowledge-based theory of a firm emerged from the resource-based theory. To date, it serves as the main basis for understanding how a firm as well as the MNC achieves a competitive advantage. The processes that underlie the theoretical concept of the knowledge-based theory, such as the creation of knowledge and knowledge sharing, are all complex in themselves; they do not occur in a straightforward manner and are not easily managed either within the firm or within the MNC.

2.1.3 The character of knowledge

Up to now, the theoretical concept of knowledge has been discussed in a rather general manner. However, knowledge itself is an elusive concept that needs a more detailed review. The following paragraphs present two approaches to narrow down the theoretical concept of knowledge. Firstly by presenting two taxonomies of knowledge, which are often referred to within knowledge-related debates. And secondly the knowledge spectrum, which identifies particularly, the explicit and tacit, as well as individual and organisational dimensions of knowledge. The rationale for presenting two approaches to map the theoretical concept of

knowledge is: the initial approach briefly introduces the reader to the main characteristics of available knowledge; the second approach discusses these characteristics individually in an in-depth manner. A combination of both approaches builds the starting point for the in-depth review of knowledge creation and knowledge sharing at firm level.

2.1.3.1 What is knowledge? Two taxonomies

Within the literature, a variety of taxonomies can be found that intend to explain what knowledge actually is, and what it is not (Blankler, 1995; Holsapple & Joshi, 2001; Kakabadse et al., 2003). One taxonomy, which is often referred to (Kakabadse et al., 2003, Kock et al., 1997; Nonaka & Takeuchi, 1995), is to develop an understanding of the differences between the theoretical concepts of data, information and knowledge. These differences are introduced in more detail within the following paragraphs. Another taxonomy of knowledge introduced by the innovation theorists Lundvall and Johnson (1994), defines the different theoretical concepts of know-what, know-why, know-how and know-who. The division of these four different types of knowledge is, to some extent, related to the aforementioned taxonomy of knowledge; however, specific differences also exist among both taxonomies that will be identified in more detail later.

Data, information, knowledge

In their comprehensive work on KM within firms, Davenport and Prusak (1998, p.1), state that within most firms there is substantial confusion around the different characteristics of data, information and knowledge and state that, ´…it is still important to emphasise that data, information, and knowledge are not interchangeable concepts. Organizational success and failure can often depend on knowing which of them you need, which you have, and what you can and can't do with each´.

In this respect, data is described as having no particular purpose or relevance, and as being exclusively a summary of objective facts about particular events. Data can potentially become transformed into information. Information is similar to a message, or a flow of messages, putting data into context (Dretske, 1981; Machlup, 1983; Nonaka, 1994), and is often present in the form of documentation, as well as audible or visible communication. Moreover, information is described as an intrinsic element of almost any activity within a firm and firms who are not aware of how to create, transform and use information are unable to successfully manage or share their information resources, their processes or information technology (Choo, 1996). As data may be transformed into information, so information may be converted into knowledge. Knowledge however, is a much more complex concept in contrast to information.

A detailed discussion on knowledge is presented later on. However, to complete the presentation of this taxonomy, two dominant characteristics of knowledge, found in the relevant literature, must be mentioned: First of all, to create knowledge, it suggests that one must combine a mixture of values, experiences, contextual information and insights, which must be used primarily to analyse past and present experiences and information. (Kakabadse et al., 2003, Kock et al., 1997; Nonaka & Takeuchi, 1995) Nonaka (1994, p.15), define knowledge as ´…justified true belief´ and stresses the importance of the belief of the individual as well as the justificational elements of knowledge and its dynamic character in contrast to traditional epistemologies. Thus emphasising particularly the truthfulness element of knowledge. This has led to the perception that knowledge has a static and absolute character. According to Nonaka (1994), in many cases knowledge resides in the individual mind, and must be articulated in order to make it available to others. Secondly, this taxonomy defines this articulation process as codification. Codified knowledge, hereafter explicit knowledge, may be found, for example, in documents. Within the codification process, there

is usually some sacrifice of knowledge because not everything that is known within the individual mind can be articulated and transformed into explicit knowledge. After codification, knowledge is easier to diffuse in contrast to knowledge that is not codified (Boisot, 1995).

Know-what, know-why, know-how and know-who

The innovation theorists Lundvall and Johnson (1994), develop a further taxonomy of knowledge. Their criticism on the taxonomy that distinguishes between data, information and knowledge, deals primarily with the bias that this taxonomy stimulates towards understanding knowledge primarily as a cognitive ability of the individual mind, and thus neglecting that knowledge is, to a large extent, located at the collective level. However as a response to the criticism made by Lundvall and Johnson (1994), it must be said that within the taxonomy of data, information and knowledge developed by Davenport and Prusak (1998), who explicitly point out that much knowledge within the firm is attributed to the collective level. Prusak and Davenport (1998), describe this knowledge as residing within routines and processes as well as norms and practices, which is a theoretical concept that had originally been put forward by Nelson and Winter in 1982.

The taxonomy of knowledge developed by Lundvall and Johnson (1994), differentiates knowledge into four types: know-what, know-why, know-how and know-who. In more detail, know-what is conceptualised as knowledge about facts, and is closely related to what is understood as information, as stated above. Know-why is associated with knowledge about principles of nature, in the individual mind and in society. Know-how basically refers to skills and capabilities. Know-who is understood as information about who knows what and who knows what to do. It further involves a form of social capability to co-operate and communicate. In particular, the different types of knowledge have been related to

different channels of how knowledge may be acquired and learned. In this respect, Jensen et al. (2007), identify that know-what and know-why types of knowledge may be acquired and learned, for instance, by reading books and articles; while know-who and know-how types of knowledge are mostly acquired and learned through practical experiences.

To conclude, both taxonomies of knowledge build a valuable basis for gaining a better understanding of what knowledge is, and what it is not. While the first taxonomy points especially to the individual mind as the key source of knowledge, and in this respect the different nature of knowledge in comparison to data and information, the second taxonomy differentiates four distinct types of knowledge, and is built on the basis that knowledge is not only rooted in the individual mind but to a large extent found at the collective level. Moreover, the second taxonomy closely connects the discussion of the theoretical concept of knowledge with the acquisition and learning of knowledge. Both taxonomies build the basis for discussion of the knowledge spectrum in the following paragraphs.

2.1.3.2 The knowledge spectrum

Understanding the two taxonomies presented above constitutes a starting point to explore what knowledge is or could be. However, the theoretical concept of knowledge is complex, encompassing a variety of both different and related dimensions. In other words, there exists a knowledge spectrum. Knowledge, and the knowledge-based theory of the firm, set key foundations within this thesis; therefore, the knowledge spectrum with its most relevant dimensions must be explored in detail. The following two paragraphs review the dimensions of tacit and explicit knowledge in particular as well as the dimensions of individual and organisational knowledge.

Tacit and explicit knowledge

The most common discussion on dimensions of knowledge is on the tacit and explicit (also codified or objective) dimension of knowledge (James, 1950; Nelson & Winter, 1982; Polanyi, 1958, 1966; Takeuchi & Nonaka, 1995), while at the same time it highlights that all knowledge, whether it is tacit or explicit, has a tacit dimension (Polanyi, 1958, 1967; Takeuchi & Nonaka, 1995). Why explicit knowledge has a tacit element is explained further within the following paragraphs. To begin with, it is necessary to review the essentials of knowledge dimensions.

The literature cited at the beginning of this section describes tacit knowledge as intuitive and non-verbalised, while explicit knowledge is regarded as being either articulated verbally or in writing. Explicit knowledge is concrete and can be stored, shared, reproduced or used relatively easily, and can be found in different forms; for instance, in audible or written document forms.

In most of the literature, explicit knowledge is not the main focus; in contrast, it lies on the tacit dimension of knowledge. The following paragraphs discuss what tacit knowledge is exactly, and why it raises so much more interest within the research arena than does explicit knowledge.

The theoretical concept of tacit knowledge is closely related to the philosopher and scientist Michael Polanyi. One of Polanyi´s (1966, p.4), most cited phrases is '…we can know more than we can tell.' What he identifies within this phrase is that individuals may possess knowledge of which they are not consciously aware, and cannot communicate. The question that springs to mind when reading this phrase is how might we understand an individual who possesses knowledge that is not recognisable as knowledge, nor can be communicated to the

outside world as knowledge. Gertler (2003), suggests that there are two explanations arising when trying to understand why we can know more that we can tell.

First of all, Gertler (2003), raises the issue of consciousness and states that what Polanyi (1966), means is that tacit knowledge is part of the background of our consciousness that allows and drives us to focus on specific tasks and to perform these tasks. Polanyi (1966), proffers the example of swimming where an individual participates but cannot articulate how they do so in every detail. This might become especially obvious in cases where the swimmer wants to communicate to a non-swimmer what swimming is all about, but realises that there are certain aspects to swimming that the swimmer performs subconsciously yet are essential to prevent a person from drowning. Secondly, Gertler (2003), considers the issue of language and the situation where tacit knowledge is also characterised by the fact that it cannot be orally communicated. As a typical way to overcome the problem of the missing verbal or written communication associated with tacit knowledge, Gertler (2003), notes that individuals tend to demonstrate what they know rather than describing it through language. The demonstration of knowledge is also an effective way to share knowledge, this will be discussed in the following paragraph.

Within the paragraph above, tacit knowledge has been related closely to the know-how of performing a specific task, therefore, a technical dimension. However, there is also a cognitive aspect to tacit knowledge. The cognitive aspect of tacit knowledge is associated with the individual and the way in which the individual perceives the world. In other words, tacit knowledge is highly specific and dependent on the beliefs, value systems and mental models of the individual that is often taken for granted (Nonaka & Konno, 1998). This argument is closely related to the theoretical concept of knowledge that the taxonomy that differentiates between data, information and knowledge puts forward.

Given that one main characteristic of tacit knowledge is that the individual is not fully aware of it, leads obviously to the question of how an individual actually acquires such knowledge, or how the knowledge is created within the individual, and how tacit knowledge might be shared among individuals. To begin with the process of knowledge acquisition and knowledge creation respectively, it must be stressed that an efficient way for the individual to acquire tacit knowledge is through the demonstration of this knowledge by one individual and the imitation, training and practice of this knowledge by the acquiring individual. In regard to knowledge sharing, Polanyi (1958), gives the example of knowledge sharing of distinct tacit knowledge between a master and his apprentice; the apprentice learns from the master by observing, imitating, practicing and interacting with him. Foray and Lundvall (1998), complement this conceptualisation by giving the examples of lawyers, doctors, business people, connoisseurs and artists who all acquire knowledge through practical long term experiences, learning by doing and by interacting with other individuals.

Spender (1996), also stresses that tacit knowledge is inseparable from its creation and application; he defines it as the dimension of knowledge that is abstracted from practice. Like Polanyi (1958), Spender (1996), argues that tacit knowledge is usually applied in a state of flow by an individual who is not necessarily conscious of its possession, and he argues that tacit knowledge, although it can not be articulated by language, may be communicated in different ways. He introduces two further dimensions of knowledge, the individual dimension and the social dimension. In this regard, his underlying assumption is that individual and social knowledge are related to each other, and that not all of an individual's knowledge may be seen as separate from the social process. Individual knowledge is, in other words, shaped by the social context in which the individual is embedded. Spender's (1996), theoretical concept of individual and social knowledge reflects the arguments put forward by Polanyi

(1958), as well as Nonaka and his colleagues (1995, 1998). Moreover, it picks up on the taxonomy of knowledge introduced by Lundvall and Johnson (1994), who specify that knowledge may not only be regarded as being attributed to the individual mind, but may also be attributed to the collective level.

Nonaka (1991) and Nonaka and Takeuchi (1995) or Nonaka and Konno (1998), underline the close relationship of tacit and explicit knowledge within their introduction of the knowledge spiral. The knowledge spiral, which states that explicit knowledge, if shared through a combination process, can become tacit through the process of internalisation, at the same time that tacit knowledge, if shared through a socialisation process, may become explicit through an externalisation process. Within the socialisation process individuals share their experiences and ideas. This socialisation process explains that all knowledge has a tacit dimension.

Within the process of acquiring explicit knowledge, the individual uses tacit knowledge in the form of constructs and rules that influence the way the individual reads, writes or talks (Gertler, 2003). The knowledge spiral also identifies further dimensions of knowledge, starting with the individual dimension, and then shared amongst different individuals in the group dimension, which may develop to the organisational dimension or cross the boundaries of the organisational dimension.

Hedlund and Nonaka (1993), and Hedlund (1994), further distinguish between three aspects related both to the tacit as well as the explicit dimension of knowledge. Tacit and explicit knowledge may take the form of cognitive knowledge, which includes precepts and mental constructs in the form of skills and of embodied knowledge, which may be found in products and services as well as in articles.

In conclusion, the paragraphs above identify the way in which the tacit and explicit dimension of knowledge constitutes an expansion of the taxonomies of knowledge identified in earlier sections. This review is important as it frames the main research question and presents the complexity related to the theoretical concept of knowledge.

Individual and organisational knowledge

To expand the discussion of the character of knowledge further, the remaining paragraphs identify the individual and organisational dimension of knowledge. In line with the discussion on the tacit and explicit dimension of knowledge, the differences between the individual and organisational dimension of knowledge are not typically clear-cut.

Tsoukas and Vladimirou (2001), address the difference between individual knowledge and organisational knowledge, by stating that individual knowledge deals with the capability of the individual to make certain distinctions whilst performing an action, which in turn is dependent either on the context, or the theory, or both of them. And by recognising that organisational knowledge cannot simply be understood as a dimension of knowledge that is created and shared by individuals who belong to a particular organisation. In this vein, Tsoukas and Vladimirou (2001, p.979), initially point to the main features of the organisation and reflect that the ´…distinguishing feature of [an] organization is the generation of recurring behaviours by means of institutionalized roles that are explicitly defined´. Additionally, they suggest that an organisation has three distinct features, which are that it provides a concrete setting in which individuals act; that it provides a set of rules including propositional statements; and that it is a community with a distinct history. Based on a qualitative case study carried out within a Greek firm, Tsoukas and Vladimirou (2001), draw the conclusion that organisational knowledge is present if the individuals within an organisation have

developed the capability to make distinctions in specific contexts, according to propositional statements, which are applied and based on experience and collective understandings.

The most important types of organisational knowledge that have been intensively discussed by various scholars deal with routines (Nelson & Winter, 1982). Routines may be associated with various different forms such as norms, rules, practices, beliefs and strategies. Levitt and March (1988), demonstrate that routines are independent of the individuals who execute them and further establish that routines are generally long-lasting and even survive the turnover of individuals in an organisation. Therefore, routines capture lessons of experience of history in such a way that the lessons learned are accessible, not only for the organisation, but also for those individuals who have not experienced the history. Nevertheless, Feldman and Pentland (2003), suggest that distinct aspects of routines are not of a static, but rather a flexible nature and, therefore, routines are likely to change and provoke different outcomes over time.

Kogut and Zander (1992), distinguish between organisational knowledge that is either information-based or know-how-based; a distinction that is similarly used within artificial intelligence, and relates to the first introduced taxonomy of knowledge presented and integrates the differences of the tacit and explicit dimension of knowledge. In this respect, Kogut and Zander (1992), suggest that knowledge, which is information-based, is represented through symbols, facts and axiomatic propositions, and embraces the ability to know what something means. This type of knowledge, it is argued, may be shared without loss as long as the rules are followed that are necessary to decode the information. In regard to know-how-based organisational knowledge, Kogut and Zander (1992), stress the accumulated character of this knowledge dimension, which has, in contrast to knowledge that is information-based, to be learned and acquired. As the term already suggests, knowledge based on know-how

implies to know *how* to do something. This approach reminds us also of the taxonomy of knowledge put forward by Johnson and Lundvall (1994), and later revived by Lundvall (2006).

In line with Kogut and Zander (1992), Blankler (1995), points out that within the organisational learning literature, the organisational dimension of knowledge has been predominately discussed in the form of routines, brains, dialogues, symbols and bodies. To extend this work, Blankler (1995), adopts and enriches a categorisation which was formerly suggested by Collins in 1993, and identifies the following five types of knowledge: Embrained knowledge, which is knowledge that is dependent on conceptual and cognitive skills and abilities; embodied knowledge that is not completely explicit but earmarked; encultured knowledge which refers to a status of shared understanding, achieved through language and social interactions among individuals; embedded knowledge, which is the form of knowledge found in systemic routines, and finally, encoded knowledge, which is either presented in hardcopy such as books, or in manuals, or electronically. Although he categorises these different types of knowledge, Blankler (1995, pp. 1032-1033), argues that the common ground that all of these different types of knowledge share, is that they are all ´…multi-faceted and complex, being both situated and abstract, implicit and explicit, distributed and individual, physical and mental, developing and static, verbal and encoded´.

To sum up, the paragraphs above identify the tacit and explicit as well as the individual and organisational dimension of knowledge. The taxonomies of knowledge and the presentation of the knowledge spectrum build the starting point for the following in-depth review of knowledge creation, and knowledge sharing, at the level of the firm.

2.1.3.3 Knowledge creation at the level of the firm

Since the time knowledge was declared to be the firm's most important resource to gain competitive advantage, firms have been viewed as knowledge creating enterprises (Choo, 1996). The following paragraphs outline the way the literature perceives firms that create knowledge, and what mechanisms the management of the firm might use to facilitate knowledge creation. Knowledge creation in firms can result in distinct knowledge assets. Four categories of knowledge assets are reviewed in detail in the following paragraphs.

Nonaka (1994), highlights that the roots of the creation of new firm-specific knowledge are the result of the conversion of tacit and explicit knowledge. Nonaka (1994), initially discusses the creation of individual knowledge, which he regards as closely related to knowledge creation, at the level of the firm; although he argues that individual knowledge must be enlarged, amplified and justified within a firm to transform it into firm-specific knowledge. What underlies his argument is that there are two dimensions of knowledge creation: the epistemological and the ontological. The epistemological dimension is characterised by the distinction and interaction between tacit and explicit knowledge. The ontological dimension is characterised by the level of social interaction. The epistemological and the ontological dimensions are brought together and enable the creation and expansion of new knowledge. In particular, four different patterns of the interaction and conversion between tacit and explicit knowledge are formulated; from tacit to tacit knowledge; from explicit to explicit knowledge, from tacit to explicit knowledge and from explicit to tacit knowledge. The process of tacit to tacit knowledge conversion is referred to as socialisation. The process of explicit to explicit knowledge conversion takes place between individuals through combination. The process of tacit to explicit knowledge conversion is called externalisation and the process reversed is called internalisation. Internalisation is seen to be

closely related to learning. All processes are described as being present in order to create new knowledge at the level of the firm. In contrast to the creation of individual knowledge, is the creation of knowledge identified at the level of the firm, and as depending on a management that allows a series of shifts of the four different modes of conversion.

The creation of firm-specific knowledge has further been a central focus among scholars of organisational learning. Their approach differs to the one introduced by Nonaka (1994), in that it is less abstract and thus more practical. Huber (1991), provides an excellent review and critique of the works in this area. On the basis of Huber's (Huber, 1991, p.89), assumption that ´…an organization learns if any of its units acquires knowledge that it recognizes as potentially useful to the organization´, he develops various different forms of knowledge acquisition. This acquisition of knowledge may be understood in a similar way to the creation of knowledge discussed by Nonaka (1994). However, it has to be seen as just one part of the wider discussion of organisational learning, which also includes information distribution, information interpretation and organisational memory. However, to compare the roots of knowledge creation between the theories introduced by Nonaka (1994), and Huber (1991), only the part of Huber's (1991), knowledge acquisition will be considered. In this respect, Huber (1991), argues that firms can acquire knowledge by five different learning processes: congenital learning, experimental learning, vicarious learning, grafting and searching. Congenital learning is described as a combination of knowledge that the firm has inherited at its conception, either by individuals or another firm, and the additional knowledge that is gained before the firm is launched or incorporated. Experimental learning is discussed as being related to the knowledge acquisition that takes place after the firm has been incorporated. It is identified as being either the result of systematic planning or of unintentional possession. Vicarious learning is identified as being related to the acquisition of

knowledge by imitation, for example, the imitation of activities that are performed by competitors. Grafting is regarded as being associated with knowledge acquisition by either hiring individuals who possess specific knowledge, or acquiring a firm that possesses a specific knowledge base. Searching is identified as potentially taking three forms: Scanning, focused search and performance monitoring.

Nonaka and Takeuchi (1995, p.3), describe that knowledge creation within the firm is the ´…capability of a firm as a whole to create new knowledge, disseminate it throughout the organisation, and embody it in products, services and systems´. Moreover, Nonaka and Takeuchi (1995), have pointed out that the essence of innovation is the constant recreation of the firm, which involves a process of ongoing organisational as well as personal renewal. Knowledge, they argue, must be built on its own, and this involves the close, intensive interactions among the individuals who belong to the firm.

Von Krogh et al. (2000), suggest that in firms there is usually an overemphasis on IT and other measurement tools when it comes to the management of knowledge creation. By applying such strict tools, it would be attempting to control the process of knowledge creation. However, strict control of knowledge creation cannot typically be achieved. A better way that management could facilitate knowledge creation would be through encouraging relationships and conversations across the different units, which can be geographically, as well as culturally, far apart from one another. More precisely, von Krogh et al. (2000), argue that the management is required to facilitate emotional knowledge as well as care across the firm. Care is identified as being related to how people treat each other; it is regarded as setting up creativity as well as playfulness.

In order to create knowledge effectively, it is deemed critical that firms create an awareness of who knows what. Cross et al. (2001), argue that this awareness might only be

achieved if the management understands how individuals develop strategic networks, and what the nature of the collective knowledge is, that is rooted within these networks. Cross et al. (2001), therefore, propose that firms have to adequately prepare their employees to connect quickly with one another so that knowledge held by particular individuals, is accessed and shared in a way that the firm might benefit. Cross et al. (2001), identify several different mechanisms that the firm can implement to facilitate the awareness of who knows what. Distinct examples presented are: the implementation of skill-profiling systems, corporate yellow pages, the development of thematic groups and the development of a specific help desk, which can encourage employees speedily towards the relevant thematic group, or to internal knowledge fairs. Thus, although it has been argued within the literature that an overemphasis on IT is not useful to facilitate knowledge creation within the firm, some tools that are implemented through the existence of IT, have been identified as facilitating the creation of knowledge and, in particular, the awareness of who knows what within the firm.

To briefly elaborate on what the paragraphs above identify, Nonaka et al. (2000), suggest that firms are constantly in the process of knowledge creation. Thus, they conclude that firms possess particular knowledge assets resulting from the inputs and outputs of the knowledge creation process. Nonaka et al. (2000), introduce four different categories of such knowledge assets: experimental knowledge assets, routine knowledge assets, conceptual knowledge assets and systemic knowledge assets. Experimental knowledge assets are identified as tacit and shared through common experiences. Examples include skills and know-how of the individual as well as feelings like care, passion or tension. Routine knowledge assets are regarded as tacit knowledge, but it is argued that they are embedded within actions as well as practices such as a specific organisational culture, routines and daily operations. Conceptual knowledge assets are identified as explicit knowledge, which is

communicated through images, symbols and language such as product design. Finally, systemic knowledge assets are regarded as explicit knowledge, but they are also systemised and packaged such as in documents, databases, patents and licences.

In conclusion, knowledge creation at the level of the firm does not follow a straightforward process: Nonaka (1994), and his colleagues (1995; 2001), pointed to the transformation process of individual knowledge into firm-specific knowledge, which involves a combination of tacit and explicit knowledge and social interaction. The organisational learning literature regards knowledge creation as knowledge acquisition. In this respect, it was established that to acquire knowledge usually takes different forms of learning. What has been highlighted among all scholars is that knowledge creation and knowledge acquisition at firm level involves a close personal interaction among its employees. IT might constitute a valuable form to support personal interaction although it clearly has its limitations. The case study will make use of the theoretical concept of knowledge creation as its basis. However, it is the aim of the thesis to make this theoretical concept less abstract by exploring it in a real context: knowledge creation within the MNC, the headquarters, and its spread of geographically dispersed subsidiaries, which are located in both developed and emerging economies.

2.1.3.4 Knowledge sharing at the level of the firm

The available literature uses different terms to describe the process of knowledge sharing at the level of the firm and the boundaries of the theoretical concepts of knowledge creation, and knowledge sharing, are not clear-cut within it. The following paragraphs mainly review the theoretical concepts of knowledge transfer, knowledge network, learning routine and learning, which are all related to each other, and explain how knowledge sharing in general is conceptualised in this thesis. Knowledge sharing takes place within and across the boundaries

of the firm. Moreover, there are distinct barriers that might occur in the process of knowledge sharing. Finally, the following paragraphs discuss which mechanisms the firm can apply in order to facilitate effective knowledge sharing.

Knowledge transfer, knowledge network, learning routine, learning

The theoretical concept of knowledge sharing adopted within this thesis is partly built on the work of the organisational theorists Argote and Ingram (2000), who conceptualise knowledge sharing as knowledge transfer, which they regard as a process that occurs if experience of a source unit in the firm affects another unit, that being the recipient unit. In particular, Argote and Ingram (2000), distinguish between explicit and tacit knowledge transfers. Knowledge transfers are, for instance, identified as explicit if the source unit informs the recipient unit about certain practices that improve performance. Tacit knowledge transfers are regarded as occurring in cases in which the recipient unit cannot communicate how the knowledge has been transferred. In particular, Argote and Ingram (2000), show that the recipient unit does not necessarily have to be an individual; it may also be a group. Knowledge, which is transmitted tacitly, is identified as having different forms such as norms or routines.

Through studying knowledge sharing in a multi-unit electronics firm and applying a qualitative research approach, Hansen (2002), introduces the theoretical concept of knowledge networks between different business units, which consist of related knowledge and inter-unit relationships. These inter-unit relationships are identified as either being indirect, which means that that they rely on many intermediaries, or direct, which is defined as relying on few intermediaries. Hansen's (2002), theoretical concept of knowledge networks differentiates itself from the theoretical concept of knowledge transfer put forward, for instance, by Argote and Ingram (2000), insofar as it does not focus primarily on the direct relationship between one source unit and one recipient unit, but proposes rather that

knowledge sharing involves multiple relationships made up of multiple source units, intermediary units and multiple recipient units.

Within their study on knowledge sharing in the Toyota network, Dyer and Nobeoka (2000, p. 347), regard knowledge sharing as being closely related to their theoretical concept of the learning routine, they define this as ´…a regular pattern of interactions among individuals that permits the transfer, recombination or creation of specialized knowledge´.

In line with the theoretical concept of the learning routine by Dyer and Nobeoka (2000), and the theoretical concept put forward by Argote and Ingram (2000), Spender (1996), describes that learning is the primary driver within the knowledge sharing process. Goh (2002, p.23), in this respect, suggests that. ´…learning occurs when knowledge in one part of a firm is transferred effectively to other parts, and is used to solve problems there, or to provide new and creative insights´.

Organisational learning scholars have targeted the question of how collective learning or knowledge sharing occurs. Daft and Weick (1984), comment that there is limited understanding of how firms make sense of their external environments, and how internal interpretation processes take place, or which organisational configurations enface such interpretation processes. Huber (1991), also notes that there is little systematic study on how shared understanding amongst different organisational members, in respect of particular events or items of information, is developed. He suggests that a shared understanding or interpretation of new information, is dependent on the level of uniformity of prior cognitive maps by the organisational members, the uniformity of the framing of the information, the degree of richness of the media, which is used to carry the information, the load of the information, and the degree of unlearning that might have to be considered in order to develop new interpretations.

Fiol (1994), argues that one should consider two contradictory prescriptions to provide an answer as to how shared understanding is developed. First of all, she argues that there must be a diversity of interpretations among organisational members regarding organised activity. Secondly, there must be a form of consensus building around these diverse interpretations of organised activity. Fiol (1994), explains that in order to create social knowledge and new organisational knowledge, firms must handle both stipulations in balance, and permit employees to simultaneously agree and disagree in regard to the content of their communication; nevertheless, firms should adopt a broad, shared framing. This broad, shared framing might be a common understanding as to how to construct arguments, and a shared understanding on how to exploit what is known within the firm. Fiol (1994), goes on to suggest that typically, there exists a trade-off between the enhancement of diversity and consensus, whilst urging firms to emphasise them both at varying times.

The paragraphs above present the theoretical concepts of knowledge transfer, knowledge networks, learning routine and learning. Although the theoretical concepts use different terms and varied nuances, in essence they all describe the theoretical concept of knowledge sharing. It is the aim of the thesis to explore this theoretical concept of knowledge sharing in more depth by placing it in a contemporary and little researched context.

Knowledge sharing across the boundaries of the firm

At the level of the firm, knowledge sharing not only takes place within the firm but also across its boundaries. For a long time the literature suggests that in order to stay competitive and to enrich the creation of innovation, firms are forced to look for knowledge bases outside of themselves. In this regard, Cohen and Levinthal (1990), have suggested that the firm's ability to successfully evaluate and use knowledge from an outside source is, for the most part, dependent on the firm's knowledge base before any knowledge sharing has taken place.

In more detail, Cohen and Levinthal (1990), highlight that firms must be able to evaluate the value of new knowledge that is external to them, share it, and apply it to their specific needs. They refer to this ability as the absorptive capacity of the firm. In this respect, it is suggested that the absorptive capacity is primarily dependent on the level of related knowledge that it possessed before the new knowledge is acquired. It is therefore firm-specific and path-dependent. Indirectly, this argument implies that the absorptive capacity within each firm is distinct and different from other firms, because each firm possesses a distinct base of knowledge prior to the acquisition of new knowledge. The overall absorptive capacity of a firm is confirmed as dependent on the absorptive capacities of its employees. In particular, Cohen and Levinthal (1990), stress that the absorptive capacity does not refer initially to the ability to acquire and share new knowledge by the firm, but states the importance of the ability to exploit this new knowledge. Therefore, the absorptive capacity does not only exist within the interaction of the firm with external sources, it also plays a vital role inside the firm among its different units.

Lane and Lubatkin (1998), who make reference to the work of Cohen and Levintal (1990), further highlight that before the firm considers engaging in knowledge sharing with another firm, or other outside sources, it must clearly understand its own knowledge base, how it transforms knowledge into capability, and how these capabilities help to meet the demands of the market. Only if the firm has a high level of self-awareness in this respect, Lane and Lubatkin (1998), argue will it find the right external source for valuable knowledge sharing.

The literature further points out that, to arrange for effective knowledge sharing of the firm with outside sources a common coding scheme is required, and the same technical language among the different parties involved must be developed. However, even the use of

such a common coding scheme and similar technical language does not, necessarily, guarantee that knowledge sharing is easy and without its limitations. One way to overcome the obstacles within the knowledge sharing process is through the assistance of gatekeepers. Gatekeepers are identified as being able to understand and to transform diverse coding schemes in order to allow for effective knowledge sharing among the different parties (Tushman & Katz, 1980).

Today, the effective sharing of knowledge across the boundaries of a firm seems to have become increasingly important for businesses. In this respect, MacCormack et al. (2007), based on a qualitative research study, explored how firms increased their innovational efforts through collaboration with networks of companies. MacCormack et al. (2007), contrast collaboration to outsourcing and understand collaboration as accessing and leveraging knowledge with partners as well as sharing risks. Studies reveal that collaboration may be regarded as one key supplement to internal management of knowledge and innovation as well as becoming increasingly important to remaining competitive.

In conclusion, the literature presents different terms and nuanced theoretical concepts to describe knowledge sharing at the level of the firm. The paragraphs above review four of the concepts in detail, especially highlighting their similarities. It was further identified that knowledge sharing does not only take place within, but also across, the boundaries of the firm. In both cases, knowledge sharing is not always a straightforward process. Some distinct barriers of knowledge sharing were reviewed in detail, along with how some mechanisms might facilitate knowledge sharing. The case study will put the theoretical concept of knowledge sharing in the context of the business network of the firm. In particular, it explores the obstacles that occur when knowledge is shared within the business network.

2.1.4 Knowledge flows within and across the boundaries of the MNC

While the paragraphs above discuss knowledge in a more general context, and mostly in reference to the level of the firm, the following paragraphs identify the theoretical concept of knowledge flows within and across the boundaries of the MNC. In particular, the paragraphs discuss how the literature conceptualises knowledge flows in the headquarters-subsidiary context. Moreover, the paragraphs review the different forms of knowledge flows that exist within, and across, the boundaries of subsidiaries, and the MNC respectively. One focus of this thesis deals with reverse knowledge flows. How reverse knowledge flows are defined in the literature and will, in the subsequent paragraphs, identify in more detail why they receive increasing attention among academic scholars.

2.1.4.1 The theoretical concept of knowledge flows

Building on the work of communication theorists and applying a nodal level of analysis, Gupta and Govindarajan (2000, p.475), conceptualise knowledge flows as taking place in the headquarters-subsidiary context of the MNC.

They define one unit as the source unit and the other as the target unit and knowledge flows in this respect: ´…to be a function of the following five factors: (I) value of the source unit's knowledge stock, (II) motivational disposition of the source unit, (III) existence and richness of transmission channels, (IV) motivational disposition of the target unit, and (V) absorptive capacity of the target unit´.

2.1.4.2 Three forms of knowledge flows in the headquarters-subsidiary context

Applying a micro-perspective, Mudambi (2002), suggests that there are three principal forms of knowledge flows found in the subsidiary besides the forward, or conventional knowledge flows, from the headquarters to the subsidiary.

Flow I is the flow sent from the subsidiary to the headquarters and parent respectively. Mudambi (2002), explains that flow I forms of knowledge may also be called knowledge transfers. Within the thesis, flow I forms of knowledge are defined as reverse knowledge flows. Reverse knowledge flows are necessary for the headquarters to exploit subsidiary-specific knowledge and competencies. This approach may also be described as adopting an outside-in approach of learning, meaning that the headquarters learns through knowledge flows, which are reversed from outside of the headquarters and sent from the subsidiaries. From the perspective of the subsidiaries, this approach might also be described as an inside-out approach of learning. Knowledge that is created inside the subsidiary is made available to the outside, which is in this case the headquarters, through reversing this knowledge.

Flow II forms of knowledge flows take place from the location in which a subsidiary is embedded into the subsidiary. Flow II forms enable the subsidiary to learn, exploit local competencies and to utilize local resources. As is the case with flow I, flow II forms of knowledge may be described as adopting an outside-in approach of learning. In this case, outside-in means however, that knowledge flows are sent from outside of the subsidiary to the subsidiary.

Flow III forms of knowledge flows are identified as taking place from the subsidiary to the location in which the subsidiary is embedded. Again, adopting a subsidiary perspective, this approach adopts an inside-out approach of learning. Knowledge is made available from inside of the subsidiary to the outside, which is in this case, not the headquarters but the location in which a particular subsidiary is embedded.

2.1.4.3 Reverse knowledge flows versus forward knowledge flows

As implied in Mudambi´s (2002), work, knowledge flows have a direction, adopting a headquarters-subsidiary perspective, there are forward or conventional knowledge flows as

well as reverse knowledge flows. Mudambi (2002), argues that knowledge not only flows in one direction, from the headquarters to subsidiaries, but also in reverse, in contrast to earlier perspectives of knowledge flows within the MNC and the broader question of why firms internationalise.

In the 1960s, Hymer (1960) and Vernon (1966), and later Dunning (1993), highlighted the internationalisation of domestic firms that firms engage with in intra-corporate knowledge sharing; however, this process would primarily involve forward knowledge flows and transfers. In this respect, the main theory suggested that the headquarters, or centre, sends knowledge to the external subsidiaries on a one-way basis with a goal of home-country knowledge exploitation, thus combining the advantage of having access to cheap labour and other resources, which are either more expensive, or absent in the home economy. In this sense, subsidiaries were primarily described as being concerned with knowledge absorption and adaptation rather than with knowledge creation or knowledge sharing. One could argue that knowledge adaptation already requires that subsidiaries are actively creating knowledge. However, as Kuemmerle (1999), pointed out, these knowledge adaptations were typically strongly dependent on the knowledge bases of the headquarters of the MNC, and not therefore expected to demand an active role of subsidiaries in providing new and valuable knowledge.
Over recent decades, research in MNCs has increasingly recognised that this traditional view of knowledge creation and knowledge sharing in MNCs no longer holds true. As a result, new theories on the MNC and how, and where, it creates and shares knowledge were developed, such as those of Bartlett and Ghoshal (1989), or Hedlund (1994), and as reviewed under 2.1.1.

To briefly touch on the essence of these theories, they argue that within MNCs, the creation of knowledge is no longer restricted to functions that are exclusively located at headquarters' level, but also within functions located on the ground of subsidiaries. In the

same vein subsidiaries have begun to be conceptualised as important drivers within the creation of the overall competitive advantage of MNCs (Bartlett & Ghoshal, 1989; Gupta & Govindarajan, 1991, 2000; Hedlund, 1994; Kogut & Zander, 1992). In particular, Doz and Santos (1997), emphasise typically that the MNC cannot strengthen its particular competitive advantage without taking advantage of the knowledge that is created in its geographically dispersed subsidiaries and other units outside of the headquarters. Put another way when applying a headquarters' perspective, it suggests that not only are there reverse knowledge flows sent from subsidiaries to the headquarters in existence, but also that these knowledge flows are necessary in order to strengthen the competitive advantage of the entire MNC.

However, it must be pointed out that until the late 1990s, research focused on subsidiaries becoming valuable knowledge creators to the overall MNC, these subsidiaries were located in developed economies such as the US (Bird & Beechler, 1995; Frost, 2001), Western Europe (Cantwell & Mudambi, 2005; Forsgren et al., 1999) and Japan (Westney, 1987). It is clearly a new approach to consider subsidiaries that are located in emerging economies such as China and India and are representing new valuable knowledge creators for those MNCs headquartered in developed economies (Cui et al., 2006; Johansen, 2007; Yang et al., 2008). The literature suggests that knowledge flows from subsidiaries, which are located in emerging economies, are likely to be different from those from subsidiaries that are located in developed economies, because there is a significant difference between the knowledge bases between the headquarters and its subsidiaries (Lyles & Salk, 1996).

Put another way, this approach may also be contrasted to the product life-cycle theory (Vernon, 1966), which suggested that once products reach the maturity phase, their production, as well as their related technology or bundle of knowledge, move gradually to the

emerging economies, implying that innovation spreads from the developed economies to the emerging economies and not vice versa.

In summary, one focus of the thesis is on reverse knowledge flows sent from subsidiaries to the headquarters of the MNC. This choice is consistent with the diagnosis of Ambos et al. (2006, p.296), which states ´[t]he reversed direction of hierarchical knowledge flows (between subsidiaries and headquarters) has rarely been considered´. The case study will focus particularly on subsidiaries that are located in emerging economies, and their respective ability to reverse knowledge to the headquarters. Moreover, the thesis concentrates on knowledge flows between the subsidiaries that were studied along with their external partners who are part of the external environment. The subsequent paragraphs discuss how the external environment of the subsidiary is conceptualised.

2.1.5 The local embeddedness and the external environment of the subsidiary

Firms do not operate and develop independently from the influence of the local context in which they are embedded. This also applies to the MNC, which in contrast to the domestic firm, owns and operates activities such as subsidiaries, in differing locations and as a result may become embedded in various different local contexts. The subsequent paragraphs have two important purposes: first of all they review how different streams of literature discuss local embeddedness, and where exactly they regard firms as becoming embedded, as well as how local embeddedness influences the process of knowledge creation, and knowledge sharing, within the firm; secondly, the paragraphs identify how the local embeddedness of a particular subsidiary is defined in this thesis, and how local embeddedness will be studied, as well as how the concept of the external environment might be linked to the business network theory of the MNC.

In the broader sense, the theoretical concept of local embeddedness, its influence on the creation of knowledge and the sharing of knowledge in the firm, have for a long time, concerned scholars departing from different streams of literature. The following paragraphs review the theoretical concepts put forward by human and economic geographers, scholars of the systems of innovation, national systems of innovation, as well as the sectoral systems of innovation approach.

2.1.5.1 Human and economic geography

Human and economic geographers have intensively studied the aspect of spatial clustering or industry agglomeration, which deals with the concentration of individuals, as well as firms and other economic activities, in distinctly-defined geographic locations. A leading theory is that the creation of knowledge, and the sharing of knowledge, are best conceptualised as the outcome of the interactive relationships among local sources, such as experts, firms, or institutions, who all possess various specific types of knowledge and competencies. Because of the interactive communication among these local sources, this stream of literature identifies that information and knowledge is created and shared with the clear intention of solving particular problems, which may be of differing natures including technical, organisational, commercial or of an intellectual nature (Bathelt et al., 2004; Bathelt & Glückler, 2002; Feldman, 1994; Ivarsson & Alvstam, 2005; Malmberg & Maskel, 2002).

2.1.5.2 Systems of innovation and national systems of innovation

Based on a broad perspective, the systems of innovation, and national systems of innovation approach, put forward that innovative firms are not isolated; they are innovative because they maintain relationships with other firms and institutions within their distinct systemic environment (Edquist, 1997, 2001). The term ‘national’ in the national systems of innovation

approach, refers to the major focus and the geographic and systemic boundaries, to which this type of approach is directed, this being the nation state. Studying the innovation system of a particular nation state establishes why particular innovations are developed within a particular country, with distinct institutions, and allows for a cross-national analysis of different innovation systems, and the potential reasons why these differ. In particular, this approach focuses on the analysis of national institutions, and how they shape firms and sectors of innovation in a particular way (Cantwell, 1995; Patel & Pavitt, 1994). In this respect, as Nelson (1993), proposes, it is important to understand that national institutions like universities, or even technical societies, are not of a static nature, but co-evolve and develop in line with the creation of particular technologies. Freeman (1995), suggests that the idea of a nation states´ systems of innovation is not a revolutionary concept of the 1980s or 1990s, rather it dates back to the late 19th century, a time when Friedrich List compared different nation states such as Germany, England and the US. He examined the differences in their economies, and how their distinct formal institutions influenced particular economic developments and capacities to compete with one another. Freeman (1995), acknowledges List's reference to certain characteristics of the more recently developed national systems of innovation approach within his theories; yet there have been substantial changes within the firms of national economies and international business arrangements over the last century, some of which List could not have been aware during his lifetime and so did not incorporate into his work. Particularly, Freeman (1995) makes mention of the rise of transnational corporations (TNCs), or the development of in-house R&D within sectors, as well as the set up of R&D outside the original knowledge bases.

In addition to what Freeman (1995), suggests during the 1990s, it must be noted that even more significant changes in the overall organisation of national economies, and at firm

level, have taken place since (Audretsch & Thurik, 2001). For instance, at the national economic level, we see that formal institutions such as national educational systems are increasingly compared to those of other nation states; a development that leads, in many cases, to major changes of these national institutions. Moreover, at the firm level and looking particularly at MNCs, we see a trend to seek R&D bases in specific regions, or locations that have traditionally not only attracted investments from such areas as Western Europe, the US or Japan, but also in countries such as those in Asia, or the Central and Eastern European region, which were not considered as possessing potential knowledge bases 10 to 20 years ago (Lundvall et al., 2002, Yang et al., 2008).

2.1.5.3 Sectoral systems of innovation

Influenced by the work of evolutionary economics, the systems of innovation and the national systems of innovation approach the sectoral systems of innovation approach, in its broader sense, also regards the local context in which a firm is embedded, as highly influential on the creation and sharing of knowledge by firms. Although the sectoral systems of innovation approach predominantly focuses on the sectoral level of analysis, it clearly integrates the aspect of the embeddedness of firms in particular local contexts such as those considered as national institutions. In particular, the question of how national and sectoral institutions shape the way firms interact with each other, how they create knowledge and learn from each other, are central (Breschi & Malerba, 1997, Geels, 2004). Malerba (2004), further points out that the relationship between national institutions and sectoral systems are important. For instance, his work identifies that national institutions may have different effects on different sectors.

The same institution might take very different forms in different nation states, and national institutions may constrain innovations in particular sectors, and institutions of a sector can become national institutions. However, the sectoral systems of the innovation

approach does not concentrate on specific geographically-defined boundaries, but on a specific sector; in this respect the sector is not necessarily understood as one distinct sector, but more as an area of technology that includes various different, yet related technologies, which are applied in various different sectors. Before reviewing the impact of the local context on knowledge creation and knowledge sharing from the sectoral systems of innovation approach, let us first look at the fundamental theoretical concepts on which this approach is based on.

Malerba (2002, p.250), provides the following definition of a sectoral systems of innovation: ´A sectoral system of innovation and production is a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. A sectoral system has a knowledge base, technologies, inputs and an existing, emergent and potential demand. The agents composing the sectoral system are organisations or individuals (e.g. consumers, entrepreneurs, scientists)´. Similar to the approach taken by human geographers, the systems of innovation, the national systems of innovation, the sectoral systems of innovation approach views the creation of knowledge as the result of interactions between firms and individuals, here called agents, through communication and the exchange of information and knowledge. Additionally, competition and command are regarded as further influencing factors of the creation of knowledge at the level of the firm (Malerba, 2002, 2004).

2.1.5.4 External environments

So far, three approaches of different streams of literature have been consulted in order to conceptualise what local embeddedness of the firm is, and how this shapes the way firms create and share knowledge. This thesis represents a micro-perspective of local embeddedness, as it recognises the existence of the principal influence of systemic, national

systemic, and sectoral systemic forms of innovation, on the capacity of knowledge creation and knowledge sharing within a firm. The study takes on therefore a more firm-specific approach. In this regard subsidiaries, which form one focal level of analysis of the case study, are conceptualised as being embedded in a particular local context such as a nation state, a region or a city, which are all characterised by specific institutional and business systems. However, it is not the aim of the case study to analyse these institutional or business systems in detail. The prime focus within the study rests with the external environment in which a particular subsidiary is embedded, or in which it develops. In line with the business network theory, the external environment has also been conceptualised as the external side of the business network of a subsidiary and the MNC, and therefore, as a compliment to the internal side of the business network, which comprises the headquarters, its subsidiaries and the units of the MNC (Foss & Pedersen, 2002; Zanfei, 2000). The literature defines the external environment of a subsidiary as consisting of a variety of different firms, institutions and other entities. The exchange between a particular subsidiary, and its partners within the external environment, has been described as especially important for the creation and sharing of knowledge and resources within the subsidiary (Andersson & Forsgren, 1996; Andersson et al., 2001, 2002). To primarily focus on the external environments of the subsidiaries instead of the institutional and business systems in which they are embedded, is regarded as a valuable approach to narrow down the elusive theoretical concept related to the local embeddedness, and also to distinguish which of the external partners are regarded as especially important by the subsidiaries to share knowledge, which in turn leads to knowledge creation at subsidiary level.

PART II

2.2 Research questions of the case study

Based on specific gaps in the available literature and which the boxes of chapter one demonstrate, the following PART II identifies several research questions that build the basis of the case study at headquarters level and at subsidiary level. Although the research questions constitute literature gaps, there is nevertheless, in a more general context, literature available that identifies specific theoretical concepts related to the research questions. The following paragraphs identify these concepts below each research question in detail. In some cases, it discusses the way in which any existing theoretical concepts could be grounded in a distinct approach to tackle a particular research question.

These approaches are not intended to constitute hypotheses that are empirically tested. In contrast, the presentation of the literature and its distinct theoretical concepts as well as the identification of particular approaches to tackle the research questions, serves as a practical way to engage with and operationlise the main research questions, and complies with the advice put forward in chapter three, which suggests that a research study that is qualitative and of an exploratory nature should still rely on some form of theoretical framework.

2.2.1 Headquarters level

In the following paragraphs, the case study sets out five research questions at headquarters level.

2.2.1.1 How do the types of knowledge that subsidiaries reverse to the headquarters differ?

The literature identifies that headquarters usually have very different motives when setting up, or acquiring, their subsidiaries. Accordingly, their subsidiaries may be concerned with a variety of different functions and roles (Birkinshaw & Hood, 1998; Cantwell & Mudambi, 2005; Dörrenbächer & Gammelgaard, 2006).

Typical functions of subsidiaries have been identified as either production or R&D or sales. Contemporary literature points out that most of the subsidiaries within a typical MNC network significantly differ in the functions that they perform, and the competencies that they develop, from those they typically possessed when domestic firms increasingly started to internationalise. In line with what has been discussed under 2.1.4, scholars like Cantwell (1995), or Bartlett and Ghoshal (1998), point to the developments that many subsidiaries made from pure knowledge recipients, and absorbers, to active knowledge creators, by starting with functions such as sales, or service and maintenance, which could be relatively easily learned, to more sophisticated functions, such as the production of components or R&D. Over recent years, especially the R&D function in subsidiaries and its ability to create technological competency, have gained much attention (Frost & Zhou, 2005; Hansen & Lovas, 2004; McEvily et al., 2004; Pearce, 1999; Shimizutani & Todo, 2008).

In line with what has been pointed out here and briefly touched on in chapter one, Gupta and Govindarajan (1991), taking the overall MNC as the level of analysis, define the following potential types of intra-corporate knowledge flows:

Input processes such as purchasing skills, throughput processes such as product, process or packaging design, output processes such as marketing and distribution know-how. Gupta and Govindarajan (1991), further discuss external market data with its strategic value of global relevance, as an important type of knowledge flow. What we do not learn from this theoretical concept is if one, only some, or all types of knowledge subsidiaries typically reverse to the headquarters, or what determines the type of knowledge subsidiaries reverse to the headquarters. Accordingly, the main focus of this specific research question is to explore the types of knowledge subsidiaries reverse to the headquarters, as well as what determines these types of knowledge. Based on the literature referred to above and the theoretical concept developed by Gupta and Govidarajan (1991), the case study is organised in a way that types of knowledge are studied according to different functions that subsidiaries perform. This approach has a tentative character. The case study may also reveal that this approach is not the best way to study differences in types of knowledge that subsidiaries reverse to the headquarters. However, this approach fits well with Trott´s (2008), as well as Mudambi´s (2008), argument that the management of knowledge and innovation must incorporate an integrated approach covering expertise from various departments and areas; thus it could best be understood as a management process.

2.2.1.2 How do subsidiaries differ in regard to the nature of the types of knowledge that they reverse to the headquarters?

The literature available does not address how subsidiaries differ in the nature of the types of knowledge that they reverse to the headquarters. Taking a broader perspective, the following

two paragraphs present the theoretical concepts of knowledge flow pattern and coopetition, which the literature discusses, and which could potentially be relevant to the second research question.

Gupta and Govindarajan (1991), develop the theoretical concept of knowledge flow patterns among different subsidiaries. According to Gupta and Govindarajan (1991), knowledge flow patterns can best be studied by concentrating on the magnitude of knowledge flows and the direction that these knowledge flows may take. Applying a two-dimensional perspective, MNCs are to be studied through focusing on the extent to which a subsidiary receives knowledge inflows, engages in knowledge outflows, and extends these to other parts of the MNC. Moreover, the theoretical concept by Gupta and Govindarajan (1991), distinguishes between four different subsidiary behaviours.

Global innovators that combine low inflows and high outflows of knowledge, integrated players that combine high inflows and high outflows of knowledge, implementors that combine high inflows and low outflows of knowledge and local innovators that combine low inflows and low outflows of knowledge. The theoretical concept developed by Gupta and Govindarajan (1991), is regarded as a valuable basis to explore how subsidiaries differ in respect to the knowledge that they create, as well as the nature of the types of knowledge that they reverse to the headquarters. Although the main focus of the thesis is on the outflow of knowledge, reverse knowledge flows, sent from subsidiaries to the headquarters, and the inflows of knowledge sent from the headquarters to the different subsidiaries are explored. This is necessary to clarify the way that the ability of subsidiaries to reverse knowledge is potentially dependent on the knowledge that they receive from the headquarters, and to study the way that knowledge is shared between the headquarters and its subsidiaries.

Tsai (2002), suggests the knowledge that a particular subsidiary has may have an effect on the relationship that the subsidiary develops with other subsidiaries and units, and conceptualises that in general subsidiaries, as well as all other units of the MNC, are in a state of coopetition with each other (Tsai, 2002). Coopetition describes a behaviour that is both cooperative and competitive at the same time. Cooperation is needed to get access to knowledge that is available in other parts of the MNC and which is of relevance to a particular subsidiary or unit in order to achieve economies of scope. Competition exists because different subsidiaries and units are typically measured and compared to each other by their economic success. Tsai´s (2002), theoretical concept is supported by scholars like Cantwell and Mudambi (2005), as well as Birkinshaw et al. (2005), who, based on 24 case studies, explored the collaborative and competetive relationships among subsidiaries and how these relationships shape subsidiary performance together with the external environment of subsidiaries. In the context of the present case study, the theoretical concept put forward by Tsai (2002), is regarded as a valuable basis to explore the differences in the nature of knowledge bases that the studied subsidiaries have, and to at least briefly explore, in the case where the subsidiaries differ in their knowledge bases, how they deal with their differences in the nature of the knowledge that they reverse to the headquarters.

2.2.1.3 In what way was the access to reverse knowledge flows from subsidiaries the reason for the headquarters to set up or to acquire particular subsidiaries?

To briefly summarise what was reviewed in PART I of this chapter, over recent decades an increasing amount of literature has developed that focuses on how MNCs have moved to the stage where they are seeking knowledge creation outside of their headquarters as well as their home economies (Almeida, 1996; Bartlett & Ghoshal, 1989; Frost et al., 2002; Michailova & Nielsen, 2006). In more specific terms, Inkpen and Ramaswamy (2007), emphasize that

MNCs will only be able to outperform competitors by exploiting pockets of knowledge that may be located anywhere across the globe, in developed as well as emerging economies, and not simply by relying on a one-way transfer of knowledge from the headquarters to their subsidiaries.

Currently there is no literature pertaining to this third research question that particularly focuses on firms and MNCs that operate in the sector of mechatronics. The sector association SPECTARIS (2009), which represents German firms and MNCs operating in the sector of mechatronics, identifies that most of the technologies related to the sector are technologically sophisticated resulting from the particularities of the German business system that offers experts in the sector along with other distinct factors such as active knowledge transfers between academia and the economy, which favour the development of high-tech-related expertise. Based on this statement and that SPECTARIS (2009), points out that most of the firms and MNCs, operating in the sector of mechatronics, are either small or medium-sized, thereby suggesting that these firms and MNCs have most of their key knowledge and knowledge creation at headquarters level or at home in Germany rather than elsewhere in the world.

However, as identified in the first paragraph, MNCs in general are increasingly searching for knowledge and knowledge creation outside their headquarters and home economy. In particular, the case study will explore in what way an MNC which operates in a sector which is not identified as having globally dispersed knowledge creation yet is searching for knowledge and reverse knowledge flows sent from subsidiaries which the management either set up or acquired abroad.

2.2.1.4 How can reverse knowledge flows from different subsidiaries be managed by the headquarters?

One question that is often raised in the broad context of KM is how knowledge can actually be managed at all. Although this question might give the impression that research and theory on KM are potentially disputable, the context of KM clearly has its relevance. Furthermore, KM has been identified as having proved to be much more relevant than being yet another fashionable management activity (Hull et al., 2000), and a key ingredient to strengthen MNC´s innovative capacities by integrating internal and external knowledge sources spread across their business networks (Phene & Almeida, 2008; Song & Shin, 2008). However, KM is a difficult task and the main reason for this is related to the circumstances where much knowledge, that is intended to become managed, is knowledge that is tacit or has a tacit element and is located within the individual, or within a particular routine, where it is not easily accessible and exploited (Grant, 1996; Malerba, 2002).

Taking the firm as well as the MNC as the level of analysis, the literature identifies that the respective managements might take various approaches to manage their knowledge. One key approach proposed in the literature deals with the importance of the firm's encouragement among its employees to engage in social relationships with each other.

The creation of knowledge as well as the sharing of knowledge has been closely related to interactive and fruitful relationships among individual employees to share what they know. In this respect, Kogut and Zander (1992), highlight that in order to successfully manage knowledge the firm must become a social community. This social community stands in contrast to the view of the firm as a group of selfish individuals who all pursue their own ambition. To form a social community, in particular within the context of the MNC, that successfully encourages the interaction amongst individuals is regarded as particularly

challenging. It is difficult to create a social community that integrates all the different subsidiaries and units that are spread around the world. For instance, the management of the MNC is likely to face language, cultural and status barriers that can interfere with the systematic development of a social community where individuals are encouraged to share their own knowledge as well as to develop a mutual learning mentality.

In line with Kogut and Zander, Van Krogh et al. (2000), argue that effective KM within the MNC is closely related to the development of an ´enabling context´. This ´enabling context´ is understood as a shared space that facilitates relationships. The context is suggested to be physical, virtual or mental, or all three of them. Von Krogh et al. (2000), identify five knowledge enablers that management might consider in order to manage knowledge flows: the installation of a knowledge vision, the management of conversations, the mobilisation of knowledge activists, the creation of the right context and the globalisation of local knowledge.

The theoretical concept of the firm and the MNC as being a social community as well as a facilitator of the development of an ‘enabling context´, which allows effective knowledge creation and sharing, is related to the organisational culture found within both the firm and the MNC. Goh (2002), proposes that the theoretical concept of organisational culture is broad, also identifies two characteristics of the organisational culture as especially important to facilitate KM, the first being that the organisational culture must integrate a form of co-operation as well as collaboration amongst employees, in order to create and share knowledge. Both co-operation and collaboration are discussed as being strongly related to trust whilst integrating a drive for problem seeking and problem solving. Secondly, there must be leaders who actively encourage experimentation of new ideas amongst their employees. In this connection Goh (2002), rationalises that by encouraging such experimentation employees must not be punished when some ideas fail to be realised as products or processes. In contrast,

what is important according to Goh (2002), is that employees learn from failures and are thus motivated to seek alternatives in order to realise their ideas.

On the basis of four practical aspects Birkinshaw and Hood (2001), identify how headquarters might manage their subsidiaries in a way that they create knowledge and new competencies. First of all, these researchers identify the importance of the allocation of seed money to the subsidiaries to allow them to create knowledge. Secondly, they suggest using formal requests for proposals. Thirdly, headquarters are encouraged to motivate their subsidiaries to turn into incubators. Finally, Birkinshaw and Hood (2001), recommend the development of international networks. In this respect, they particularly point to the importance of international employee rotations and the appointment of idea brokers who are located within the MNC. These idea brokers would primarily have the task of bringing together seed money, new ideas and knowledge.

To conclude, taking a rather broad perspective, the existing literature presents several different approaches as to how firms and MNCs effectively manage their knowledge. The case study explores in an in-depth manner how the headquarters management of the MNC approaches the management of reverse knowledge flows which are sent from its business network of subsidiaries.

2.2.1.5 In what way and why does the headquarters face obstacles when managing and exploiting reverse knowledge flows from its subsidiaries?

Because the literature on reverse knowledge flows in the context of the MNC is still in its infancy, it is clear that there is also little discussion on obstacles that the headquarters management of the MNC faces when managing and exploiting reverse knowledge flows from its subsidiaries. An exciting exception is the contribution by Harzing and Feely (2008), who, based on a socio-linguistic theory, explore the theoretical concept of the language barrier at

the level of the MNC. Language barriers are identified as becoming more severe once MNCs rely on more intense forms of communication, such as increasing linguistic diversity and increases in worldwide operations. Furthermore, language barriers are identified as one reason why knowledge, or technology transfers, do not taken place in the headquarters-subsidiary context because, for instance, they are rated as being to risky by the management of the headquarters.

Taking a broader perspective, there is further literature available that deals with obstacles in respect of the management of knowledge transfers. Most prominent in this regard is the contribution by Szulanski (1996). However, Szulanski (1996), primarily studies obstacles in respect of the management of knowledge transfers at the level of the domestic firm and not the MNC (Gupta & Govindarajan, 2000). Szulanski (1996), conceptualises obstacles in respect of the management of knowledge transfers as being the result of the characteristics of the knowledge transferred, the source, the recipient and the context in which the knowledge is transferred.

The nature of the obstacle to knowledge transfers incorporated by the recipient of knowledge, is closely related to the theoretical concept of absorptive capacity, which goes back to the contribution made by Cohen and Levinthal (1990). Absorptive capacity is, in a broader context, identified within the literature as a dynamic capability which is one key factor influencing the firm to achieve an overall competitive advantage (Zahra & George, 2002).

Moreover, the literature suggests that an obstacle to effective knowledge exploitation is related to its cost. To exemplify the particularities of knowledge exploitation, von Hippel (1994), uses the theoretical concept of information, and suggests that although information can be acquired and transferred relatively easily from one location to another, at little or no

cost within a firm, technical information may become problematic, meaning that it is not easy to acquire, transfer or to use. Von Hippel (1994, p. 430), argues that the process of acquiring, transferring and using of difficult information can significantly raise costs for the firm. He defines the sticking point of a particular unit of information in a specific instance ´…as the incremental expenditure required to transfer that unit of information to a specified locus in a form usable by a given information seeker´. Von Hippel (1994), claims that if the cost to transfer particular information is low, the value of that information is low; in contrast, the value would be high if the cost to transfer particular information is high.

In a similar way to von Hippel (1994), Teece (1977), in the 1970s propounded that although there had been a wide acceptance within the literature on technological change, that to develop a new process, or a product, requires significant resources, and it had been underestimated that substantial costs are incurred when exploiting and transferring a technology. The reasons for this relates to the belief that a technology can be compared to a blueprint, which can be applied at a nominal cost to all. This assumption is misleading, Teece (1977), explains, that it neglects the significant part of knowledge, that which is tacit. Teece (1977), suggests that the cost to exploit and transfer a technology includes the costs associated with transmission and absorption. These costs can be especially high in cases where either the technology is complex and/or the recipient does not have the capacity to absorb it.

To summarise, the paragraphs above present a discussion of obstacles contained in the litertature in respect of KM and knowledge exploitation. The contribution by Szulanski (1996), dealing with typical obstacles, relating to the management of knowledge transfers at the level of the domestic firm serves as an important basis to explore this fifth research question. Moreover, the paragraphs above identify that KM and especially knowledge

exploitation can significantly raise costs for a firm. The case study intends to explore how the exploitation of reverse knowledge flows from subsidiaries raises costs for the entire MNC.

2.2.2 Subsidiary level

The following paragraphs present eight research questions at subsidiary level.

2.2.2.1 When and why does a particular subsidiary regard the headquarters as interested in its specific knowledge base?

Therefore, to sum up what has been reviewed in depth in PART I of this chapter, MNCs have been conceptualised as entities that achieve a distinct competitive advantage only through the successful localisation and integration of knowledge embedded in their networks of diverse units and subsidiaries (Birkinshaw & Hood, 1998; Doz et. al, 2001; Porter, 1985). Adopting a more micro-specific subsidiary perspective, up to now there is no literature available that explains at what point, or why, a particular subsidiary regards the headquarters as interested in its specific knowledge base.

In a broader context, Gupta and Govindarajan (2000), apply a nodal level of analysis in the context of their MNC research, argue that the value of a particular unit´s knowledge base in relation to other units within a network, is characterised by two aspects: the knowledge base must be non-duplicative and the non-duplicative knowledge must constitute relevant knowledge to the other units within the network.

Based on this theoretical concept, the case study in respect of this first research question is operationalised in a way that it will be one focus, to analyse whether a particular subsidiary regards its specific knowledge base as non-duplicative, and at the same time being of relevance to either the headquarters, or to other subsidiaries and units, within the overall MNC network. Additionally, when a particular subsidiary is identified as regarding its specific knowledge base as non-duplicative, and at the same time of relevance to either the headquarters or to other subsidiaries and units within the overall MNC network, the case

study will explore whether this evaluation causes it to also regard the headquarters as interested in its specific knowledge base. This approach has a tentative character. The case study may also reveal that this approach is not an appropriate way to study when, or why defining whether or not a particular subsidiary regards the headquarters as interested in its specific knowledge base. Linked to the philosophical view of interpretivism, the inductive approach towards the field research is the main focus. Therefore, it is not the aim to test the theoretical concept by Gupta and Govindarajan (2000), but to use it as one starting point to engage with the data.

2.2.2.2 In what way does a particular subsidiary perceive the headquarters as motivating it to create new knowledge and learning capabilities?

The literature does not examine in what way subsidiaries perceive their headquarters as motivating them to create new knowledge and learning capabilities. In a general context, scholars like Argote et al. (2003) and Yahla and Goh (2002), highlight that rewards and incentives, which are not necessarily financial but may also be social rewards, are important aspects of the effective KM process.

The specific context of this research question, particularly in relation to the headquarters-subsidiary context, will to some extent explore whether rewards and incentives cause a particular subsidiary to perceive the headquarters as motivating it to create new knowledge and learning capabilities. However, it is primarily the focus of this research question to identify and analyse whether some distinct aspects not yet discussed in the literature, are important enough to provoke a particular subsidiary to perceive that the headquarters is motivating it to create new knowledge and learning capabilities.

2.2.2.3 How and why does a particular subsidiary face obstacles when sharing knowledge with the headquarters?

In a broader sense, the typical obstacles that are faced when knowledge is shared have been reviewed in PART I. With reference to the particular context of the MNC, Birkinshaw and Hood (1998), suggest that the MNC can only share knowledge effectively, and thus without major obstacles, if it knows where key knowledge is located and how it can be applied by other units within the MNC.

Moreover, the literature suggests particularly that there needs to be a context similarity between the knowledge that a unit sends, and the knowledge that another unit receives, in order to share knowledge effectively (Ahn et al., 2005). Inkpen and Dinur (1998), highlight that different units within the MNC are embedded in distinctly different contexts. These contexts are identified as covering: a strategic dimension, a decision-making dimension, an environmental dimension, a cultural dimension and a technological dimension. Based on this theoretical concept, the research question is partly operationlised by exploring in what way context similarity is important in order to minimise or prevent obstacles that subsidiaries face when sharing knowledge with the headquarters. Again, this approach to engage with the data has a tentative character; the data which will be generated can potentially also not allow for this approach of exploration.

2.2.2.4 In what way is a particular subsidiary willing to reverse its key knowledge to the headquarters?

The literature does not explore aspects that influence the way subsidiaries are willing to reverse their key knowledge to their headquarters. What has been discussed is that through the increasing engagement of subsidiaries in functions that require learning and creativity,

subsidiaries can potentially become of high strategic importance to the headquarters. This has been identified as becoming manifest in the reality that a subsidiary possesses specialised knowledge about a specific product, combined with the central responsibility for all the major functions that are associated with the product such as: R&D, sales and marketing on a worldwide basis (Rugman & Verbeke, 2001). Accordingly, it has been suggested that if a subsidiary is in such a position that it possesses specialised knowledge of and full responsibility for a product, there exists a substantial dependency of the headquarters on the subsidiary, and that at the same time, such a collection provides the subsidiary with considerable bargaining power, which it might execute in order to access firm-specific resources and to achieve acceptance of its own agendas (Mudambi & Navarro, 2004).

2.2.2.5 In what way does a particular subsidiary face risks when it reverses its key knowledge to the headquarters?

The literature does not explore potential risks that subsidiaries face when they reverse their key knowledge to the headquarters. In the broader sense, Szulanski (1996) as well as Mahnke et al. (2006), state that a source may be reluctant to engage in knowledge transfers when it feels that it could lose the ownership of its key knowledge, or particular advantages, related to the fact that it is in possession of key knowledge.

2.2.2.6 Who or what belongs to the external environment of a particular subsidiary?

PART I of this chapter identified that the external environment of a subsidiary can potentially take different forms; each form characterised by a unique mix of external partners such as a distinct customer and supplier base, academic institutions or other businesses. The external environment of a subsidiary is described as a valuable platform for the subsidiary to learn, to access and share knowledge, which it can then integrate into its own activities. In other words,

the external environment has been identified as the major knowledge source besides the internal MNC resources that a subsidiary typically exploits (Andersson et al., 2001; Duc Tiep, 2007; Johansen, 2007). The case study intends to analyse how subsidiaries differ in regard to the external environments that they develop. This aspect has not yet been comprehensively studied.

2.2.2.7 How does the access to a specific external environment influence the way knowledge is created within a particular subsidiary as well as reversed by a particular subsidiary to the headquarters?

The literature does not explore how the access to a specific external environment influences the way knowledge is created in a particular subsidiary, or is reversed by a particular subsidiary to the headquarters. This research question has been formulated in a rather general manner. The exploratory case study should provide valuable aspects which should be build the basis for future research in this area.

2.2.2.8 Why do the employees of a particular subsidiary regard their subsidiary as offering a valuable knowledge base to the headquarters besides the influence of its external environment?

The literature does not examine why the employees of a particular subsidiary regard it as offering a valuable knowledge base to the headquarters. Similar to the seventh research question, this research question has been formulated in a rather general manner. It is included because it is regarded as relevant to explore the sources of knowledge and knowledge creation in the subsidiaries. In particular, the aim of the study is to establish whether the subsidiaries regard knowledge sharing with external partners as key to their ability to create knowledge, or

whether they regard other sources or particularities as more influential on their ability to create knowledge.

In conclusion, this chapter set out to provide the reader with an in-depth understanding of the available literature in regard to the main research question and research subject. Furthermore, the aim was to identify distinct literature gaps that are the basis for the defined research questions. These research questions are explored at headquarters and at subsidiary level. Chapter five of the thesis presents the results of the case study and will provide an in-depth discussion of the results with reference to the literature that was reviewed here.

3. METHODOLOGY

In their reflection on qualitative research, Corbin and Strauss (2008, p.1) define the term methodology as: ´[a] way of thinking about and studying social phenomena´.

The following chapter presents the methodology that underlies the case study conducted as part of this thesis. The chapter opens with a brief summary of the main points of the methodological background as well as a review of the general components that allow a social scientist to carry out, and to present, a valuable research study. Subsequent paragraphs give an overview of the basic research philosophy adopted by the researcher, in particular, the three different philosophical views of positivism, interpretivism and realism. Building on a philosophical view of interpretivism, the overall research approach concentrates on induction. Following the discussion on induction, the case study research strategy is explained in detail and the major advantages of following this strategy are explored and its limitations are highlighted. Subsequent paragraphs review how and why this case, or its sub cases were selected followed by an amplification of the basic characteristics of the MNC that is studied. These paragraphs illustrate how research access was negotiated and show that the research was ethically performed. The final two parts review the data collection methods, detailing the

major aspects of the qualitative secondary and qualitative primary data, and ends with an analysis of the strategies used to identify the data.

3.1 Summary of the important cornerstones of the methodological background

As identified initially in chapter one, the overall research purpose of this thesis is to shed light on the management of reverse knowledge flows sent from subsidiaries to the headquarters of the German-based MNC, and the creation of knowledge within these subsidiaries. In this respect, the creation of knowledge is mainly studied by focusing on the sharing of knowledge between the subsidiaries and the external environments that they develop.

Following a critical review and evaluation of the main research question in the context of existing literature, it became evident that the case study is of an exploratory nature and is therefore designed to map out different dimensions of the two main phenomena under consideration. In general, exploratory case studies have been identified as useful when no concrete or vague research questions are formulated before the fieldwork has taken place (Tellis, 1997). The main aim of the exploratory case study is to develop new theoretical insights.

Because of the two different levels of analysis, being the headquarters level and the subsidiary level, and the different research settings, a decision was made that although the case study follows a firm-specific approach focusing on a single instance, this case has to be split into sub case studies. Four case studies were conducted in detail, based on qualitative data collection methods and combining secondary data. These took the form of documents that were provided, to a large extent, by the MNC itself, with primary data collection in the form of semi-structured and in-depth interviews. With regard to the semi-structured and in-depth interviews, the case study was mainly carried out in two different phases. The first phase was carried out at headquarters level in Germany, and the second phase was carried out

at subsidiary level in the Philippines, in the USA and in India. Two different interview guides were prepared that included a range of questions that should be answered at some point during the interviews, one for the headquarters level and one for the subsidiary level. The qualitative data collected was analysed through the implementation of a grounded theoretical framework.

3.2 General ingredients for valuable research

An important question within all academic disciplines is a very general but important one, focusing on what type of research can be considered to be good or valuable (Salmon, 2003).

The answer to the question above will obviously be influenced by the specific discipline of those who are asked. There are certain elementary ingredients, or important aspects related to any research study independent of the discipline, which are critical in order to perform research that is not exclusively valuable to the researcher undertaking the research study, but appeals to a wider academic community interested in a particular topic.

The study carried out as part of this thesis complies with the respected prescription for noteworthy research that should be followed that Saunders et al. (2009, p.5) define as:

- ‘Data are collected systematically.
- Data are interpreted systematically.
- There is a clear purpose to find out things´.

Moreover, there are important factors for consideration or competencies that particularly social science researchers should hold, in order to generate research that is valuable, and at the same time takes a deep interest in protecting participants from any harm that could possibly result in connection with their contribution to the research (Silverman, 2006). Within this case study, the researcher adopted an approach that complies with the generally accepted characteristics of social scientists that Denscombe (2002, p. 3), describes as being:

- ´Open-minded and self-reflected,
- recognises the rights and interests of the participants, and is
- cautious about claims based on the findings'.

3.3 Different philosophical views on research: positivism, interpretivism and realism

Bryman and Bell (2007), explain that the essence of philosophical considerations within academic research for example business research, is to serve as a basis to provide answers to the question of what can be considered as being adequate knowledge development. More concretely, this argument implies that the way one thinks about knowledge development has a direct influence on how one's research is performed. In what manner different philosophical considerations influence the nature of research will be reviewed in more detail later on.

To understand different philosophical considerations, Saunders et al. (2009), primarily suggest examining the three philosophical views of positivism, interpretivism and realism. Within the subsequent paragraphs, these three perspectives are discussed further, particularly focussing on the differences between them in respect of the concepts of ontology, epistemology, research objects, data collection methods, understanding of truth, reliability and validity, and, going further to evaluate why the philosophical view of interpretivism is adopted within the case study. In so doing, some of the major aspects of the characteristics of the case study are explained.

3.3.1 Positivism

In the specific area of social research and business research respectively, Bryman and Bell (2007), examine one essentially important question that asks whether it is possible, or appropriate, to study the social world by applying similar rules, tactics and procedures that are

applied within the natural sciences, such as in physics. Turning to natural sciences as a paradigm for conducting research has been referred to as adopting the principles of positivism, or as taking a positivistic view.

What are the principles of positivism derived from the natural sciences? Gill and Johnson (2002), explain that the bottom-line of natural sciences and positivistic research principles is the creation of covering-laws that describe past and future observations. The covering-laws are formulated through hypothesis testing and causal analysis. In particular, Gill and Johnson (2002, p.41), identify that natural scientists and positivists apply the following format: 'A causes B or Variation in A causes variation in B that is Stimulus A causes Response B´. What underlies this main principle is that researchers claim that there is a separation between reality and the observer; meaning that reality and the researcher are two independent entities (Caldwell, 1994).

Besides this ontological consideration, positivism further suggests that this reality, which is of an objective nature and separate from our minds, can be studied by the researcher in a way that is value-free (Gill & Johnson, 2002). The research objects are considered to be clearly separate to the researcher; for this reason the researcher has the opportunity to study their characteristics without being influenced by the research objects in any manner. In terms of data collection methods, positivism has been strongly linked to quantitative research method (Creswell, 2008).

As mentioned above, positivists argue that understanding the truth insists on, and develops through, a test of formulated hypotheses and causal analysis (Gill & Johnson, 2002).

In terms of the compliance with reliability of research that is predicated on a positivistic view, it has been indicated that this research is reliable because results can potentially be reproduced through imitation. In respect of the warranty of validity, it has been

suggested that validity is achieved because the data collection methods that are linked to positivism are the most appropriate to measure reality (Remenyi et al., 1998).

3.3.2 Interpretivism

In a similar way to the relationship forged between positivism and quantitative research, some literature highlights that interpretivism and qualitative research are closely linked to each other (Kaplan & Maxwell, 1994; Williams, 2000), whilst further suggesting that both, interpretivism and qualitative research are neither precise nor generally agreed terms.

One major aspect of interpretivism, and qualitative research, and social constructivism, is that it does not emphasise primarily the measurement element within conducted research. Thus researchers adopting an interpretivistic view do not aim to quantify human action; their major concern is to study the lives of people, experiences, behaviour, emotions and beyond (Corbin & Strauss, 2008; Denzin & Lincoln, 2005). In particular, qualitative researchers intend to explore how people attach meaning to their experiences and to events that occur. For this reason, they usually study participants in open settings, for example, in the firm in which particular conditions naturally develop (Willig, 2001).

Maykut and Morehouse (1994, p. 21), state that: ´[t]he goal of qualitative research is to discover patterns that emerge after close observation, careful documentation, and thoughtful analysis of the research topic. What can be discovered by qualitative research is not related to sweeping generalisations but contextual findings´.

What underlies these key aspects of interpretivism is the ontological view that reality and the researcher are not separate entities, but are intrinsically tied to one another as a whole. The essence of the epistemological consideration in regard to interpretivism is that reality is socially constructed, and that it cannot therefore be considered as being determined in an objective manner (Husserl, 1965). The research objects are regarded as participants who are

studied and analysed through the eyes of the researcher, which implies that the manner of how the researcher studies and analyses the participants is shaped by the researchers´ own experiences. At the same time, the researcher is affected by the participants. The data collection methods are mainly of a qualitative nature; there are several different methods mostly encompassing interaction between the researcher and the participants, and closely linked with them is the understanding of the theory adopted by interpretivists (Rossman & Rallis, 1998). In this connection, the critical aspect is that the aim of the research study is less the testing of a theory or of something that is already known, but more to look for new insights with regard to particular research questions and to develop theories that are empirically grounded.

Nonetheless, it is therefore essential that the researcher disposes of at least some presumptions of the outcome of their research and is put into the position accordingly to verify whether these assumptions are confirmed by the data or not (Flick, 2006).

The reliability of research that builds on interpretivism is assumed to be assured through a situation where the researcher recognises within his or her work that the outcome is subjective; nevertheless, it is sometimes possible to reproduce the same results when conducted by another researcher, although typically this is not an easy task: In general reproduction, business research is rarely conducted in a straightforward way (Bryman & Bell, 2007).

Validity is warranted by interpretivists through demonstrating, in a transparent manner, how and why the particular research outcome was attained. Again, the recognition of subjectivity is a major focus. The literature on research philosophies highlights that it is an important aim, particularly for researchers adopting an interpretivistic view, that another

researcher or reader can understand the important aspects of the experiences that shaped the researcher when conducting the research study (Mays & Pope, 1995; Stake, 1995).

3.3.3 Realism

Philosophical considerations that are based on realism are, to some extent, related to positivism (Saunders et al., 2009). For example, similarly to positivism, realism also builds on a separation between reality and the researcher as being two independent entities. In particular, it is assumed that a social reality exists, including social phenomena such as actions and institutions, which are concept-dependent, meaning that the researcher not only has to explain the production or effects of the social phenomena, but also must gain an understanding of what they mean (Sayer, 1992), which can be studied by the researcher without taking the personal perceptions and beliefs of the researcher into account. There are different forms of realism such as critical realism for example, which are described as an alternative view to positivism and empiricism (Sayer, 2000).

Adopting a realist philosophical view implies, in contrast to the positivistic view, that it is not the aim to develop covering laws, but to describe particular tendencies that can be applied not only to things but also to human beings. These tendencies do not always have to become realised; their related advocacy is typically dependent on other conditions too (Manicas, 2006). In terms of data collection methods, reliability and validity, realists share similar assumptions to positivists (Bryman & Bell, 2007).

3.3.4 The adoption of interpretivism

The case study used for this thesis is built on the philosophical view of interpretivism. Alvesson and Deetz (2000), state that for business researchers adopting an interpretive view; firstly, the firm that is studied constitutes a social site that shares its major characteristics with

other forms of community. By this means, the focus mainly lies on the social aspect in contrast to the economic aspect. Secondly, the participants who are studied are not regarded as research objects, rather as sense makers. Thirdly, the theory is neither regarded as a tool for classification, nor tested in a straightforward or direct way and finally, the goal of the study is to reveal reality that is understood as being socially produced and reinforced through the compliance of norms, routines and daily activities.

3.4 Quantitative and qualitative research

To briefly sum up the paragraphs above, the particular philosophical view that a researcher adopts, affects the nature of the research. In the broadest sense, the literature on research methods differentiates, in particular, between quantitative and qualitative research. Quantitative research is sometimes described as the antithesis to qualitative research; however, the differences between both are not always strong, and an analogy of the two is complex (Bryman & Bell, 2007; Denzin & Lincoln, 2005; Lin 1998). Because some important aspects of both types of research were already reviewed, this paragraph exclusively summarises the significant differences. On the basis of an overview by Creswell (1998, 2003), the differences in the main research aspects are:

Table 1: *Quantitative and qualitative research*

	Quantitative research	Qualitative research
What is the outcome of the study?	Generalisation / probable causality	Particularisation / meaning
How can the relationship between researcher and research objects be described?	Distanced	Close
Which sampling technique dominates?	Random / representative	Selective / purposeful
What is the main focus of the data collection?	Numbers	Words / images
Which form of data analysis dominates?	Central tendency	Multiple perspectives
Which standard is anticipated?	External validity	Participant / reader / researcher validity

3.5 Inductive theory

An inductive research approach is applied within the case study. A perfect example of the inductive approach is that the outcome of the research is formulated into theory. The inductive approach is an alternative research method to the deductive research approach, which primarily deals with the questioning and testing of posed hypotheses or theories. Taking an inductive approach is strongly linked to the philosophical view of interpretivism (sometimes also to social constructionism) (Easterby-Smith et al., 2008).

Why is the inductive approach the most adequate method to deal with the data collected as part of the case study? The dominant reason for the selection of an inductive research approach deals with the exploratory nature of the main research question posed, along with the overall research purpose, which is to shed light on the management of the headquarters of an MNC in respect of reverse knowledge flows. These flows are sent from subsidiaries to the headquarters and the research looks at how these knowledge flows are managed and shared within the overall practices of the MNC, as well as the creation of knowledge within three subsidiaries. It is the particular aim of the case study to look at the external environments that the subsidiaries develop. As it could not be known in advance how and why the different subsidiaries engage in reverse knowledge flows with the headquarters, or in what way types of knowledge are sent by the subsidiaries to the headquarters, or why particular external partners are to be found in the external environments, and how some engage in knowledge sharing with a particular subsidiary, the inductive approach, which is the most appropriate approach in cases where researchers pose research questions that are intended to open new ways of enquiry with regard to a particular research topic is the preferred approach.

By definition, inductive theory implies a lack of existing theories to answer particular research questions. Marshall (1997), points out that researchers who might be regarded as naïve, argue that there are no adequate theories available that deal with research questions for human beings who are unable to understand any phenomena without reference to some theory already in existence. Marshall (1997), further clarifies that what the inductive theory puts forward is not the general lack of theories to understand and answer research questions, but a lack of scientific theories to appropriately answer the research questions.

3.6 The overall research strategy

The following paragraphs review the major characteristics of the case study strategy. In particular, what advantages result from following the case study strategy and the major limitations of following such a strategy.

3.6.1 What is a case study?

The literature on research methods does not provide a consistent separation of the terms research approach, research design and research strategy in respect of their particular definitions (Eisenhardt, 1989; Yin 2003). In the research study at hand, the overall research strategy is defined as the case study research. In general, the case study strategy can be applied by various different disciplinary perspectives that might originate from social sciences, but also the disciplines of medicine or criminology. By applying a sociological perspective towards the case study strategy, Stark and Torrance (2005), state that the researcher emphasises the social construction of the case as well as how the case is realised in social action. By this means, the case can have a policy focus and be combined with a particular site such as a physical location. The aim is to study people by identifying how the case is perceived by individuals within a particular site. More conceptually, this involves that

the researcher conducting the case study, captures and makes sense of the complexity in regard to any social activity. This social activity is understood through studying the meaning of how people being social actors encounter and influence particular settings; hence, the case study approach applied by a sociological perspective, builds on the basis that social reality is generated through social interaction in dependency on a particular context and history. Following the case study strategy, the researcher typically tries to discover and describe an analysis before building a theory.

In general, social scientists can use a variety of different research strategies, research designs and methods to undertake their research studies. However, whichever one of them is finally adopted has more to do with the main research question asked than the nature of the research itself. Within the present research study, the case study research strategy has been selected. Why is the case study research strategy the most appropriate strategy to tackle the study of the thesis and the main research question posed? Yin (2003, p.1), points out that ´[c]ase studies are the preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon with a real-life context´. The case study strategy can be considered to be a research strategy that encompasses a particular interlinked approach to the research design, data collection method and data analysis that is adopted in a particular research study. Yin (2003, p.13-14), defines the essence of the case study strategy in the following two steps:

- ´1. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident.
- 2. The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on

multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from prior development of theoretical propositions to guide data collection and analysis´.

A variety of different case study types exists. Stake (1994), suggests that the three most common types include intrinsic case studies, instrumental case studies and collective case studies.

Intrinsic case studies are identified as studies whose primary aim is to allow for the best possible understanding of the case. Quintessentially that the case reveals the story and it is only a secondary aim to understand and explain an abstract or generic phenomenon.

Instrumental case studies are regarded as those whose primary aim is to understand a particular phenomenon or interest. By this means, the case constitutes a supportive role that offers the researcher an opportunity to study a particular phenomenon.

Collective case studies are conceptualised as having the primary aim of offering the researcher the opportunity to explore a particular phenomenon in the context of several different cases. The interest in one case is typically much less than within instrumental case studies. The case study of this thesis combines the theoretical concepts of instrumental case studies and collective case studies.

While taking a case study strategy, the unit of analysis is critical. Tellis (1997), suggests that case studies usually focus on a particular system rather on an individual or group; in particular, the focus to concentrate on one or two aspects that are a prerequisite to understanding the system being studied.

As touched on above, case studies can integrate various different data collection methods, for example, archives, interviews, observations and questionnaires, and the evidence can be of a quantitative and qualitative nature, there are case studies that integrate both

natures of evidence (Eisenhardt, 1989). However, as Richie and Lewis (2003), suggest, the term case study is, although used in various different ways, strongly linked to qualitative research. Adopting a qualitative mode of inquiry in case study research tells us that the researcher is conducting his or her research, based on the philosophical perspective that there are episodes of nuance to discover, and that there is a sequentiality of happenings in context as well as the entirety of the individuals who are studied (Stake, 1995).

Within this case study a qualitative case study is conducted. Some essential aspects of qualitative research in general were already presented under 3.4. By adopting a qualitative case study research strategy, Gillham (2000), highlights that qualitative methods enable the researcher:

- To explore phenomena where other methods such as experiments would not be appropriate or ethically acceptable
- To discover phenomena which have been unknown or partly unknown until the time of inquiry
- To analyse phenomena that are complex
- To explore what really happens by looking for an informal reality that is found by looking into the case
- To get to know the case thoroughly
- To establish which processes lead to specific results whilst not necessarily being interested in the significance of the results

The value of theory is one of the most important ingredients when successfully conducting case studies. This aspect has to be kept in mind even if there are only semi-developed theories or simple frameworks in place at the beginning of the case study research process. During the process of the research, it is important however, that the researcher

develops theoretical frameworks which, initially, enable the researcher to make sense of the data collected, then these theoretical frameworks enable the researcher to perform tests during the course of the case study research for plausibility of the study (Hartley, 2004).

Moreover, in order to present a thesis that includes research following a case study research strategy to be valuable for science and practitioners, it is important to define clear boundaries of the case being studied, and denote how much time the researcher has allowed for conducting the research study (Stark & Torrance, 2005).

Why is it important that the research study draws clear boundaries of the case? Boundaries are important to permit a high degree of study depth. As the depth of study is one of the main advantages of applying a case study research strategy, it is critical that this depth is achieved. Within the present case study, the case is one MNC. Although the study focuses on one single case, a German-headquartered MNC, there are actually four sub case studies being conducted: One at headquarters-level in Germany, one at subsidiary level in the Philippines, one at subsidiary level in the USA and one at subsidiary level in India.

As mentioned in the paragraph above, in most research studies, it is critical to have a defined time frame of how long the research is going to take and how much time can be devoted to conducting the research study.

The definition and compliance with time constraints may differ due to, for example, limitations set by a financial budget, the availability of participants, or the researcher himself / herself (Bryman & Bell, 2007). With regard to the time frame of this case study, eight months have been scheduled for the field research period; including the sub case study carried out at headquarters level as well as the sub case studies carried out in the various subsidiaries.

3.6.2 What are the advantages of case studies?

As touched on in the paragraphs above, Gummesson (2000, p. 3), suggests that the major advantage of following a case study strategy is that it allows the researcher to study a phenomenon in an in-depth manner, and states that ´[c]ase study research is becoming increasingly accepted as a scientific tool in management research. If you want an in-depth understanding of the mechanisms of change, you need not study a large number of cases´.

Moreover, by following a case study strategy, the researcher adopts one of the most flexible research approaches. This flexibility corresponds to different aspects of the case study strategy. Hakim (1987), highlights that one main characteristics of this flexibility deals with the fact that there are, potentially, various different types of case studies that can include a variety of different data collection methods. Hakim (1987), identifies the choice that a researcher has between the focus on an in-depth single case study as another form of flexibility, as in a critical case, or to enlarge a research focus by looking at multiple cases.

3.6.3 The limitations of case studies

As is the nature of all research strategies, the case study strategy has its own limitations. Some of the principal ones are reviewed in the subsequent paragraphs.

In the first instance, one limitation, or challenge that can emerge by following a case study strategy is that the research settings and research sites where the case study is planned to be performed are either not available or have restricted access (Darke et al., 1998).

A further limitation in respect of following a case study strategy can be that the research is not suitable for the generalisation of its findings. However, if the lack of generalisation is perceived as a limitation of the case study strategy, one has to consider what generalisation actually means. Generalisations are often contrasted to particularities. However, as Stake (1994), highlights both, they can also become linked to one other; a link

that he views as the naturalistic generalisation. According to Stake (1994), naturalistic generalisation is an understanding of the knowledge of a peculiarity that can also become recognised in contexts that are new or foreign. In other words, naturalistic generalisations develop by taking an empirical, as well as an intuitive approach, to identify objects or issues within and outside contexts through recognising the similarities of incidents.

Closely linked to its limitation of not providing a meaningful matrix for generalisations, the case study strategy is often criticised for lacking the potential to become a valuable basis for theory building. However, Eisenhardt (1989), argues that following a case study strategy can become a valuable means to derive new theories; nonetheless, she urges that in order to allow theory building from case studies it is vital to define precisely the research questions and constructs at the beginning of the research process; to collect data systematically while using the same rationale for the definition of the research questions, as would be the case within any research that focuses on hypotheses testing; to remind oneself that although research questions and constructs are clearly defined they are tentative, and most importantly to value and to keep in mind that the research process begins by following the ideal that there is no theory under study, or hypothesis being tested.

3.7 Selection of the case: The MNC

Some of the key characteristics of the MNC under study are briefly reviewed here. In this context, the subsequent paragraphs identify which particular characteristics of the MNC have encouraged the researcher to select the MNC as the case for the in-depth case study that builds the basis of the thesis.

3.7.1 Characteristics of the MNC leading to its selection as the case

Considering the MNC profile, it needs to be explained why only one business was selected to be studied, and why the mechatronics business was selected instead of the other main business. Firstly, why was only one business selected? Considering the main research question, its principal focus on the management of reverse knowledge flows that are sent from subsidiaries to their headquarters, together with the relatively broad approach considering different types of knowledge that may also be reversed and the creation of knowledge at subsidiary level, this case study is already a complex one. In addition to explore how both businesses deal with the management of reverse knowledge flows from their subsidiaries, and the various different types of knowledge that may be reversed as well as created at subsidiary level, would make the study broader in its coverage including a cross-analysis such as how both businesses differ in managing reverse knowledge flows sent from their subsidiaries, or how the subsidiaries differ in respect of their knowledge creation processes according to the different natures of the external environments that they develop, but, at the same time, also result in a decrease in depth considering the answer to the main research question.

Furthermore, why was a mechatronical business selected instead of the other main business? The mechatronical business is the origin and heart of the MNC, dating back to the 19th century when the founder started the production of scales that he had formerly developed in close cooperation with the local university.

Some of the important characteristics that influenced the researcher to choose the mechatronical business include the following:

- Strong Presence in Asia

The mechatronics business has, in contrast to the biotechnology business, a subsidiary which focuses on R&D as well as production not only in India but also in China. Moreover, it has a further subsidiary that is exclusively devoted to R&D in the Philippines.

- Products

Products are the outcome of the successful integration of different functions across the MNC. One example of this integration is a range of simple as well as robust industrial weiging products tailored for the Asian market.

- KM across MNC boundaries

The mechatronics business maintains (like the biotechnology business) a diverse network linked to certain academic institutions along with various sector-specific partnerships.

3.8 Research access and the importance of research ethics

An important challenge for business researchers is the right to gain access to a particular environment in order to carry out their research study. At the same time it is challenging, when carrying out research, to define and to comply with the appropriate research ethics at all times during the research study process. The following paragraphs detail how access to the case was negotiated, and defines the principal research ethics and demonstrates how they were observed during the case study research.

In order to gain access to a particular research setting, it is important to identify the relevant individuals (in this case staff members within the MNC) who have the authority to make a decision to permit or deny a particular research request (Saunders et al., 2009). To negotiate access to the case, a preliminary meeting with the Chief Executive Officer (CEO) was held.

Before this first meeting took place, the researcher prepared a short summary of the main research focus of the thesis. Furthermore, the researcher had reviewed some of the most important aspects of starting a qualitative field research. The aim of this was to remind the researcher that, as is the case in any field research study, the researcher must, throughout his or her work, remain reflective including knowing oneself and realising how the researcher might affect, or at the same time, become affected by the research setting that is being studied (Crabtree & Miller, 1999).

During this meeting, the main research question was discussed, stating the overall research purpose; the research objectives were presented in detail incorporating the relevance of the topic giving particular attention to the management of the MNC. It was suggested that the thesis will present new knowledge and insights about the MNC, and could thus serve as a point of departure for the management leading to reflection and thereby potential change. This is an approach that is usually taken within business and management research, because when interested in a particular research topic, firms traditionally respect academics and look expectantly to their findings and guidance (Mc Niff & Whitehead, 2000).

This MNC was selected primarily because it offers an appropriate research setting for exploring the research topic. The specific advantages were introduced in chapter one. To briefly touch on the most exciting characteristics of the research, it must be said that this MNC is not a large, global player but a typical Mittelstand firm that operates in the sector of mechatronics, an area that is contemporarily un-researched with regard to the overall research question and therefore constitutes important criteria for its selection.

Another reason why the case was considered, deals with the fact that the researcher has, historically, developed close ties with this MNC, which is primarily, that the MNC was founded by the ancestors of the researcher. Its management and subsequent development were

sustained by the smooth handover from one generation to the next within the founder's family. Today, the MNC is a public firm where the founding family owns the majority of its shares; the result of a complex heritage structure. Although the researcher does not own any shares, it is well known within the MNC that the researcher belongs to the founding family and therefore the question might be raised as to what challenges this link places upon the case study. In particular, the most obvious challenge deals with the handling with a potential bias of the participants (interviewees) and the researcher (interviewer) who take part in the case study. One form of bias could be that the participants may feel forced to participate in the case study. To overcome this potential bias, the researcher pointed out, on several occasions before the interviews took place, in written as well as in verbal form, that the participation in the interview is not obligatory and that if a participant feels uncomfortable when taking part in the interview, it could be stopped immediately and any of their data would be erased. During all interviews, the researcher frequently confirmed that the participants felt comfortable being interviewed; on several occasions, mainly within the interviews with the most senior managers, it became clear that the participants were used to being interviewed.

Another potential bias is that the participants answered the questions asked in a particular way, leading the researcher to believe that they did not reflect their personal views; for instance, participants were reluctant to mention facts that could potentially harm them personally either directly or indirectly due to the researcher being part of the founder's family and who could negatively exercise a degree of power over them. How was this potential bias tackled?

First of all, within qualitative research and especially in the form of an interview, the challenge of bias always exists. How can a researcher ever ensure that the participant communicates his / her true view? Or establish whether this view reflects reality, and if this

view is understood to its fullest degree by the researcher? Nevertheless, one should discuss how the research study might demonstrate that the data is reliable and not simply reflecting what the participants felt the researcher needed to hear. To ensure the reliability in this respect, the research study benefitted from having two levels of analysis, being the headquarters' and the subsidiary level. At each individual level, the primary data that emerged from the interviews was explored and similarities were highlighted. For the next step, the data collected at both levels of analysis was compared. To put this in a less abstract way, each level of analysis was explored in terms of how it mirrored the other one. In this way, the research verified that concepts and categories that emerged from one level of analysis were also recognized and reflected in the data that emerged from the other level.

Secondly, potential bias was further removed by relying on an overall research topic and selecting research questions that did not, in any respect, touch on particular management qualities of certain people.

Linked to the paragraph above, it is vital to conduct a research study in such a way that at all times during the study, the researcher must strictly maintain correct ethical standards. This is especially important when the research includes an interaction with people, because it may not be the aim of any study to do any harm to those who are studied or interviewed. Robson (2002), points out that by maintaining an ethical approach the researcher also achieves a much more valuable study compared to one where an ethical manner is not maintained, because by conducting a research study which is systematic and explicit about all aspects of a firm thus enables a clear assessment by others, and is therefore of better quality and is much more useful to science as well as to practitioners.

In order to conduct a research study that complies with all necessary ethical standards, one major contributor is to achieve the informed consent of those who take part in the

research study. Informed consent is achieved when all necessary information, the research purpose, and the cornerstones of the research study, as well as the source or sources for funding are revealed, in advance, to the participants. Moreover, the participants must be informed who the researcher or the researchers conducting the study is / are; how the data is collected; how the data is analysed and subsequently presented; as well as what the major requirements for the participation in the research study are; and how much time the participants are asked to devote to taking part (Richie & Lewis, 2003; Silverman, 2006). Particularly as the interview may be seen as a contract between the researcher and the interviewee(s) who take(s) part in the interview. The contract should be negotiated between the two parties before the interview takes place. Moreover, it should be guaranteed that the interviewee may terminate the contract, or agreement to participate in the research study, at any time within the interview (McQueen & Knussen, 2002).

Another factor, which is required in a research study that complies with ethical standards, is confidentiality. Obviously, there are some participants for whom confidentiality in regard to their participation in a particular study is not important. However, business researchers, like all other researchers, should reassure any participants that, whether they regard confidentiality as important or not, confidentiality is assured and even more importantly must keep this promise (Israel & Hay, 2006).

In summary, within the case study of this thesis a straightforward approach was adopted in order to guarantee the confidentiality of all participants. At the beginning of each interview, the participants were verbally informed that an assurance of confidentiality will be applied to any outcome of the subsequent interview.

3.9 The use of secondary data

Researchers not only have the opportunity to concentrate their analysis on data that is new but also to gather secondary data, being data that has already been collected primarily for a different purpose under consideration. In the context of business research, there is usually rich and copious secondary data available. The following paragraphs review one principal type of secondary data, that being documentary data, and the forms of this data to which the researcher refers within the thesis are briefly summarised. Reflecting particularly on the location of the data and how it was made available. Also the main advantages and disadvantages in relation to the use of documentary data are identified. And finally, a summary explains how the documentary data was evaluated.

3.9.1 Using documentary data

The use of documentary data can be a rich supplement to other data collection methods such as interviewing, allowing the researcher to learn more and to keep up-to-date with the developments in the different cases under consideration. Patton (2002, p.295), suggests that ´[l]earning to use, study, and understand documents and files is part of the repertoire of skills needed for qualitative inquiry´.

3.9.2 Documentary data used within the case study

There are several different types of documentary data used within the case study at hand. What they have in common is that they are all in written form. Examples include annual reports from the last five years, brochures and presentations that have been edited by employees of the MNC, these have been studied along with articles about the MNC which were produced for, and published in, sector-specific journals.

3.9.3 The location and availability of documentary data

Typical locations of documentary data are libraries, government publications and noticeably the internet (McGuiness & Short, 1998). Moreover, business researchers can typically find documentary data for the firms they are studying during the research process.

However, according to Saunders et al. (2009), secondary data or documentary data can, in many cases, be difficult to locate in firms. In particular, Saunders et al. (2009), point to the role of gatekeepers. Gatekeepers are those employees who are aware of the existence and availability of secondary data and have the ability to either help or hinder the researcher to access it.

3.9.4 Advantages of documentary data

There are a number of advantages in using secondary data. First of all, secondary data and documentary data are generally less expensive and quicker to collect than primary data. Secondly, by using data that already exists, researchers face fewer problems that usually occur by collecting data themselves due, for example, to lack of access. Thirdly, secondary data can be an important source for comparison; for instance, in relation to the primary data that has been collected. In many instances, it is used for triangulation of the research findings. Fourthly, secondary data is typically described as being unobtrusive (Bryman & Bell, 2007).

3.9.5 Disadvantages of documentary data

There are also several disadvantages in using documentary data. First of all, the actual existence of secondary data does not confirm its accuracy and consistency; therefore, it is the task of the researcher to find out how precise and reliable the data is. Within this process it is critical to establish out who created the data and for what reason. Secondly, documentary data may contain errors; examples might be clerical errors, typographical errors or distortion. In

the context of the firm, distortion can, for instance, be executed by particular employees who aim to use the data to defend a personal argument yet so does not reflect reality (Glueck & Willis, 1979). Other disadvantages of secondary data may include that it is not available, or it is too costly to collect, or that access is not easily gained, or that it simply does not help the researcher in any way, because the method of collection diverts from the purpose laid down by the researcher (Denscombe, 2002).

3.9.6 Qualitative evaluation of documentary data

Within the evaluation process of qualitative documentary data, Thorne (1994), reviews the two steps that a researcher may wish to follow and that were adopted by the researcher of this study. Firstly, the researcher may interact with the textual data; this interaction typically results in a two way process where the researcher starts to question what has been written and tests the text, focussing particularly on content analysis. The researcher must evaluate whether or not the data available matches the purpose of the research study. The second step is where the researcher is in a position to apply various analytical tools that are used when evaluating primary data, for example, the researcher can move between the states of subjectivity and objectivity as well as distance and immersion when engaging with the data at hand to ensure the reliability and validity of the data.

3.10 The use of primary data

The following paragraphs discuss how the primary data was collected. In particular, the semi-structured and in-depth forms of interview are the main focus. After a brief summary of the main characteristics, the style in which the semi-structured and in-depth interview process uncovers knowledge is reviewed. The subsequent paragraphs summarise what competencies

an interviewer should possess in order to optimise data collection by semi-structured and in-depth interviews.

3.10.1 Semi-structured and in-depth interviews

This case study primarily uses qualitative interviews to generate data. Qualitative interviewing is often related to an interview form which is semi-structured, or at least partly structured, and generally of an in-depth nature (Easterby-Smith et al., 2008). Mason (2002), proposes that qualitative interviewing can best be identified as:

- An interactive exchange of dialogue between two or more individuals which can take place face-to face or through a telecommunication medium
- An interaction that is characterised by a relatively informal style
- A conversation that is centred around a particular research topic or particular research questions that the interviewer would like to explore while the structure of the interview must maintain a flexible and fluid structure and a form that allows for unexpected topic-related discoveries
- An approach with the underlying assumption that knowledge is situated and contextual and it is the task of the interviewer through the interaction with the interviewee to achieve that particular topic or research questions-related questions are put to discussion and therefore the situated knowledge can be revealed

The researcher used semi-structured and in-depth interview methods to collect data that could be processed and analysed later and used to answer particular research questions. However, as summarised in Mason (2002), and the aforementioned aspects of qualitative interviewing, this interview research method is more than just a tool to create data, it is a medium to reveal and uncover new knowledge. With regard to this process of knowledge discovery, there are varying perspectives identified in the literature on research methods; this

applies especially in respect of the question of where knowledge is located and how it develops (Bryman & Bell, 2008; Denzin & Lincoln, 2005).

Legard et al. (2003), outline two major distinctions that are, firstly, knowledge resides within the interviewee of the interview and is, within the interview, transferred from the inside to the outside by the interviewee in a reflective manner while it is the main role of the interviewer to ask his / her questions in such a way that this knowledge transfer from the inside to the outside of the interviewee is facilitated effectively. Secondly, Legard et al. (2003), identify that knowledge is discovered through the interaction between the interviewer and the interviewee. The basic idea leading to this perspective is that knowledge is discovered through social interaction, in which all parties who interact with each other stimulate and influence the creation of knowledge. This perspective of the creation of knowledge in interviews typically raises some critique amongst those researchers and academics adopting a positivistic view who argue that data and knowledge, that is collected by interviews, lacks reliability and validity, as the interviewer plays a vital role in influencing the outcome.

In the case study at hand which is based on the philosophical view of interpretivism, both perspectives in regard to the discovery of knowledge in interviews are supported. The critique concerning the lack of reliability and validity of the creation of knowledge in interviews is rejected. Reliability and validity of data and knowledge are warranted because both the intention, and the main aim of the interviewer, is to discover answers and knowledge that could not be defined in advance. The researcher adopted the view that the interviewer's role is to prepare questions that stimulate answers to particular research questions; therefore, the interaction between the interviewer and interviewee is critical to elicit the knowledge that resides within the interviewee.

The following three tables present the various interview schedules of the semi-structured and in-depth interviews carried out in more detail:

Table 2: *Interview schedule Germany*

Interviewee	**Date and location**	**Duration of interview**
1	1.10.2008 (Headquarters office)	**Kick off meeting 1 hr**
2	8.10.2008 (Headquarters office)	**1 hr**
3	10.10.2008 (Headquarters office)	**1 hr**
4	13.10.2008 (Headquarters office)	**50 min**
5	16.10.2008 (Headquarters office)	**1.5 hr**
6	30.10.2008 (Headquarters office)	**1 hr 20 min**
7	14.11.2008 (Headquarters office)	**1 hr**
8	19.11.2008 (Headquarters office)	**1 hr**
9	30.04.2009 (Headquarters office)	**1 hr**

Table 3: *Interview schedule Philippines*

Interviewee	**Date and location**	**Duration of interview**
10	21.01.09 (Subsidiary office)	**1 hr**
11	20.01.09 (Subsidiary office)	**1 hr**
12 Software Engineers (SEs) **- SE 1** **- SE 2** **- SE 3** **- SE 4** **- SE 5**	 20.01.09 (Subsidiary office) 20.01.09 (Subsidiary office) 20.01.09 (Subsidiary office) 21.01.09 (Subsidiary office) 21.01.09 (Subsidiary office)	 **45 min** **55 min** **50 min** **45 min** **50 min**

Table 4: Interview schedule USA

Interviewee	**Date and location**	**Duration of Interview**
13	05.03.09 (Subsidiary office)	**1.5 hr**
14	05.03. 09 (Subsidiary office)	**45 min**
15	05.03. 09 (Subsidiary office)	**50 min**
16	05.03. 09 (Subsidiary office)	**55 min**

17	06.03. 09 (Subsidiary office)	**1 hr**
18	06.03. 09 (Subsidiary office)	**1 hr**
19	06.03. 09 (Subsidiary office)	**45 min**

Table 5: *Interview schedule India*

Interviewee	**Date and location**	**Duration of interview**
20	02.04.2009 (Subsidiary office)	**50 min**
21	02.04.2009 (Subsidiary office)	**1 hr**
22	02.04.2009 (Subsidiary office)	**55 min**
23	02.04.2009 (Subsidiary office)	**1 hr**
24	03.04.2009 (Subsidiary office)	**50 min**
25	03.04.2009 (Subsidiary office)	**1.5 hr**
26	03.04.2009 (Subsidiary office)	**1 hr**
27	03.04.2009 (Subsidiary office)	**1 hr**
28	03.04.2009 (Subsidiary office)	**50 min**

In order to explain how the interviewees were selected, the prinicpal aim of the case study, as set out in chapter two, was to determine different types of reverse knowledge flows according to several different functions that the MNC performs. For this reason, it was critical to interview senior managers across these different functions. The result of this approach demonstrates that the research study relies primarily on a superior management perspective.

In the Philippine subsidiary the MNC principally has only a R&D function, and for this reason, the interviews primarily targeted its software engineers. This selection could be regarded as problematic because it might complicate comparisons among the different subsidiairies that were studied. However, the case study at subsidiary level in the Philippines is regarded as a rich supplement to the research study. In particular, the focus on the R&D

function proved to be less of a problem than anticipated before the research study was carried out, because R&D-related knowledge in all of the other subsidiaries that were studied was identified as one of the two most relevant knowledge flow types that subsidiaries reverse to the headquarters.

No interviews were conducted at subsidiary level in China, only one interview with the managing director of the Chinese subsidiary was conducted at headquarters' level in Germany. The initial focus of the study was on the Indian, US and Philippine subsidiaries and, therefore, the case study was planned and organised without fieldwork taking place in China. Fieldwork for this context could be added in a future study.

3.10.2 The competencies of the interviewer

There are various abilities that an interviewer should posses in order to make the semi-structured and in-depth interview form a valuable data collection method. The researcher incorporated the following suggestions found in contemporary literature on the subject:

3.10.2.1 Before the interview

Wengraf (2001), focuses particularly on the competencies that are expected of an interviewer before the interview takes place, and points out that this form of interview requires a long-term, forward planning phase in which the interviewer:

- Informs the interviewee, preferably in written form, about the most important aspects of the study and assures their confidentiality as well as the anonymity of his / her contribution,
- ensures that a room is available in which the interview will take place that offers an atmosphere that is noise free and pleasant to all parties taking part in the interview,
- confirms the availability of the interviewee 7-10 days before the interview takes place,

- ensures that tape recorders are working; is equipped preferably with a reserve should the first one cease to work; the interviewer should ensure that sufficient note pads and pens are available for notes taken either during the interview, or soon after the interview takes place.

3.10.2.2 During the interview

During the semi-structured and in-depth interview, the researcher was aware that she must control the interview in such a way that the interviewee answers the questions and does not digress far from the research questions or themes. In this way, the researcher acted as a guide; being in control of the interview process, guiding on one hand whilst being open and attentive on the other hand to the themes that arise during the interview that may not have been considered before. Flick (2006), emphasises that the interviewer must mediate between the interview guide and the research questions along with the particular style of the interviewee. This may, as Flick (2006), mentions, be especially relevant in cases in which particular questions have already been answered by the interviewee en passant and therefore the researcher faces a situation in which to decide ad hoc if that question should be raised again or not: To ask the same question again could potentially provoke different answers or motivate the interviewee to expand the answer to a particular question; however, it could also cause irritation in respect of the interviewee feeling misunderstood, or required to provide a different answer to the one given.

3.10.2.3 Following the interview

Another quality that an interviewer should possess and one that was essential within the interviews that were conducted here is that of an administrative nature; the researcher had to ensure that as much data as possible is collected during the interview and that it was

summarised later as accurately as possible. During the present research study, the interviewer recorded all of the interviews on tape with the prior agreement of the interviewees.

The three paragraphs above reviewed the key competencies that an interviewer should possess in order to amass valuable data by adopting a semi-structured and in-depth interview data collection method. Some of the points that have been reviewed may appear to be self-evident, nevertheless, it is important to be aware of them and bear them in mind while using this particular data collection method, in order to provide research that is valuable not only for oneself but also for a broader academic and non-academic audience.

3.11 The analysis of qualitative data

The following paragraphs review how an understanding of the collected data is developed. In particular, focussing on some of the strategies that enable researchers to understand data; qualitative data as in the present case, are reviewed as well as some of the peculiarities of qualitative data analysis in case studies. A grounded theory framework was selected in order to analyse the data that was collected during the course of the case study, and the main aspects related to this framework are underlined.

3.11.1 First steps

To develop an understanding of the collected data, the researcher adopted the following strategy suggested by Miles and Huberman in 1994. Miles and Huberman (1994), state that the analysis of qualitative data can typically be differentiated into three different phases: Data reduction, data display and conclusion drawing and verification.

Data reduction is identified as the process in which data that can potentially be stored in various locations such as field notes in research diaries, or transcriptions, is concentrated by

the researcher in a particular manner, for instance, by the development of summaries and coding.

Data display, in respect of qualitative data, is associated with an extended written text along with graphic interpretations, for instance, charts and networks.

Within the third phase, which deals with conclusion drawing and verification, the researcher is seen as being in the position to analyse what the collected data reflects. By this means, the researcher starts to identify regularities and patterns. Within this third phase, Miles and Huber (1994), determine that the researcher must keep a sceptical and reflective mode in case the data collection is not completed. Even if the data collection is incomplete, the researcher could begin to draw conclusions at this stage; however, any conclusions must serve as a tool for verification, and may only be finalised when the data collection is complete.

3.11.2 The analytical framework of grounded theory

Typically there are no clear-cuts between the data collection and the analysis phase in interpretive or qualitative studies (Terre Blanche & Durrheim, 1999). This seems to be especially true in terms of case study research. Patton (2002, p.447), states that ´[t]he case study approach to qualitative analysis constitutes a specific way of collecting, and analysing data; in the sense that it represents an analysis process. The purpose is to gather comprehensive, systematic, and in-depth information about each point of interest. The analysis process results in a product: a case study. Thus, the term case study can refer to either the process of analysis or the product of analysis, or both´.

The principles mentioned above are mostly reflected in the analytical framework of grounded theory that has been followed within the case study of the thesis.

Corbin and Holt (2005, p.49), define the grounded theory framework as ´… an integrated theoretical formulation that gives understanding about how persons or organisations or

communities experience and respond to events that occur´. Corbin and Holt´s (2005), definition of grounded theory is built on a definition on theory introduced by Hage (1972), which Corbin and Holt (2005, p.49), summarise as ´…a set of concepts that are integrated through a series of relational statements´.

Strauss and Corbin (1998), state that the essence of implementing a grounded theory framework is to develop particular concepts along the data collection phase. The development of these concepts is, according to Strauss and Corbin (1998), achievable by following strategies like coding, axial coding as well as selective coding. The developed concepts are then refined through an ongoing comparison of the data collected and the concepts at hand. The aim is the development of categories which emerge and are grounded within the data that has been collected that ultimately become the basis for the formulation of theory.

In conclusion, the chapter above provided an outline of the methodology adopted in the case study carried out as part of this thesis. In particular, the chapter identified that the research conducted builds on the philosophical perspective of interpretivism, adopts an inductive research approach, and follows a case study research strategy. Moreover, some important characteristics of the case were reviewed in detail. It was further explained how the research access was negotiated and how ethical considerations were taken into account during the course of the research process. The chapter ended by presenting the data collection methods followed by a review of the main aspects of the data analysis stage.

4. MECHATRONICS

Habib (2007, p. 12) describes mechatronics as ´… a philosophy that supports new ways of thinking, innovations, design methodologies (synthesis and analysis) and practices in the design of new intelligent products and engineering systems´.

Products built on the basis of mechatronical expertise can be found in a variety of different forms such as scales, computed tomography (CT) scans, dishwashers and gas turbines to name but a few. The following chapter provides an introduction to this young and dynamic discipline. The first paragraphs of this chapter explore the origin of the term mechatronics in more detail and will give an overview of the various definitions of mechatronics and its related scope. In subsequent paragraphs, the roots of mechatronics are discussed along with a summary of some of the discipline's recent developments. Additionally, it will demonstrate how mechatronics have provided significant innovative input for many sectors. This chapter further identifies the main challenges that arise within the development and design processes of mechatronical products, and concludes by reviewing two important sector federations, EUROM and SPECTARIS, in more detail.

4.1 Mechatronics- what is it?

The term mechatronics was originally coined in 1969 by an engineer working for the Japanese Yaskawa Electronic Corporation. With this newly developed term, the engineer intended to describe a discipline that had emerged by the extension and improvement of mechanical systems through the integration of electronics. Bishop and Ramasubramanian (2008), identify that at this stage, mechatronics did not encompass computation. Since 1971, Yaskawa Electronic Corporation has protected the term mechatronics as a trademark; however, since 1982 the term is freely available (Harashima et al., 1996; Heimann, 2005; Kyura & Oho, 1996).

Ever since the term was coined, there have been many debates of what mechatronics is and what it should encompass (Habib, 2007). The outcome of these debates is that there is no one specific definition of mechatronics (Vasić & Lazarević, 2008). This also holds true in respect of its scope. Consequently, the range of products and processes that mechatronics is supposed to encompass varies substantially across different literatures (Kyura & Oho, 1996). Moreover, a review of the literature (Habib, 2007; Kuttig, 2005), reveals that the boundaries between the definitions of mechatronics as a discipline, mechatronical products, and mechatronical systems, are not always clear-cut. Nonetheless, there is wide acceptance that mechatronics, and mechatronical expertise respectively, are seen as the basis for the next generation of machines, robots and other intelligent systems in a number of different environments (Sachidanand, 1998) and that mechatronics, although the term and the discipline are still in their infancy, has been available for some time before the term was adopted; in the early days it was primarily used to describe electronically-controlled mechanical products, which were created with an idea to develop a new product through the integration of features from another domain (Van Amerongen, 2004).

More specifically, it is suggested that mechatronics is the multidisciplinary integration of the ´muscle´ of mechanical systems and the ´brains´ of electronics as well as the software (Hollingum, 1999). This combination is further partly reflected through the term mechatronics itself - ´mecha´ which relates to mechanism and ´tronic´ which relates to electronics (Heimann, 2004; Kuttig, 2005).

One basic definition of mechatronics, which is often cited, goes back to Harashima et al. (1996, p.1), who defined mechatronics as ´…the synergetic integration of mechanical engineering with electronic and intelligent computer control in the design and manufacturing of industrial products and processes´.

Another definition of mechatronics that is often referred to, goes back to 1986 when the Industrial Research and Development Advisory Committee (IRDAC) of the European Union stated that ´[t]he term "mechatronics" refers to a synergistic combination of precision engineering, electronic control and systems thinking in the design of products and manufacturing processes. It is an interdisciplinary subject that draws on the constituent disciplines and includes subjects not normally associated with one of the above´ (Blankendaal, 2007; Roberts, 1999; Tomizuka, 1996; Van Amerongen, 1999).

As touched on in the definitions provided by Harashima et al. (1996), and IRDAC (1986), Grimheden and Hanson (2005) and Onwubolu (2005) highlight the emphasis of these definitions through the terms synergy and integration. In more detail, Hewitt (1993) points out that the underlying concept is that the final product or system that results from mechatronical thinking, constitutes much more than the sum of its parts. To put this idea in a less abstract manner, thereby implying that the new product or system not only offers a new level of performance, but will be able to operate in ways that have not been envisaged hitherto. Hewitt's observation is supported by Auslander (1996); however, Auslander (1996) primarily

highlights the increasing importance of computer science in mechatronical products and systems. In this vein, Auslander (1996, p.5) suggests ´…that the uniqueness associated with mechatronics comes from its exploitation of computation to create systems that are qualitatively unlike any that came before´.

Auslander's (1996, p.5) own definition is more straightforward and broader compared to the definitions mentioned earlier. It simply states that mechatronics is the ´…application of complex decision making to the operation of physical systems´.

Isermann (1999, 2000) summarises what most definitions of mechatronics have either directly or indirectly in common, and comes to the conclusion that mechatronics is generally seen as multidisciplinary emerging through the interactions of the following elements:

- Mechanical systems e.g. mechanical elements, machines, precision mechanics,
- electronic systems e.g. microelectronics, power electronics, sensor and actuator,
- IT e.g. systems theory, automation, software engineering, artificial intelligence.

Until today the IRDAC definition, especially, still finds general acceptance; however, as highlighted by Auslander in 1996 and by Roberts in 1999 the IRDAC definition seems dated; in particular, it appears as if it has been overtaken by the developments of computer aided design (CAD) systems and embedded microprocessor systems. Moreover, there is a general understanding within the literature (Comerford, 1994; Kyura & Oho, 1996; Roberts, 1999), that most definitions of mechatronics have a rather broad character which is perceived as not being necessarily problematic; however, it is identified as having led to the understanding that the majority of engineering expertise can be regarded as mechatronical expertise. Moreover, as Bradley (1997) points out, what is not typically immediately observable among the consumers and users of mechatronical products is the multi-layered nature of the related mechatronical systems. The multi-layered nature of these mechatronical

systems is created through the link of individual mechatronical systems through the transmitting and receiving of data. Bradley (1997) cites the example of the auto-focusing camera that would be generally regarded by the consumer and user as one mechatronical product although it would integrate several distinct mechatronical systems in itself including the body, the lens and the flashgun.

Overall, the scope of mechatronics and mechatronical products and systems includes a wide range of consumer and commercial products. Vossler and Dutt (2005) identify the following mechatronical product and system categories:

- Electronics & consumer durables e.g. audio equipment,
- white goods such as dishwashers, etc.,
- vehicle systems e.g. automobiles, small aircrafts, etc.,
- communication systems e.g. radios or radar equipment, etc.,
- on-board control systems e.g. aerospace, space systems, etc.,
- biomedical instrumentation e.g. CT scanners, security systems at airports, etc.,
- office equipment e.g. fax machine, printer, etc.,
- industrial machinery & equipment e.g. gas turbines, etc. and
- large scale transportation & equipment e.g. cranes, construction equipment, etc..

From the paragraphs above we can conclude that although there are various attempts to define what mechatronics is and what its related scope is, it is almost impossible to find an all-encompassing definition in regard to both terms. Bishop and Ramasubramanian (2008), suggest that this is a healthy sign, because it would demonstrate that this relatively new discipline is alive and well as it remains a youthful subject. In the same vein, Wang et al. (2008), regard mechatronics as a discipline that increasingly challenges traditional engineering knowledge bases and practices and calls for new educational programmes.

4.2 The roots of mechatronics and recent developments within the discipline

The following paragraphs review the roots of mechatronics. Diverting to its origin that lies within mechanical engineering, and includes an evaluation of the technical differences that exist between mechanical systems and mechatronical systems. Examples are given of the evolution of mechatronical systems in respect of those found in automobiles. A short review is discussed pertaining to some important, general developments, relating to different areas of mechatronics. The final two paragraphs focus on some recent developments within the discipline together with some predictions for the future.

As introduced under PART 4.1, mechatronics as a discipline emerged through the integration of different elements. However, the origin of mechatronics is undoubtedly found within mechanical engineering (Ceccarelli et al., 2006; Vasić & Lazarević, 2008). Alciatore and Histand (2003), reviewed the discipline of mechanical engineering in detail. It was developed as a professional practice in the early 19th century and provided the important basis for the expansion of the industrial revolution. Furthermore, developments in mechanical engineering are identified as being anchored in the overall changes within the industrialising societies and the need for, to give two specific examples, new ways to ensure transportation systems that were stronger than those relying on horse power, and the requirement for moving manufacturing from the workshop bench to large factories. Later within the 20th century, Alciatore and Histand (2003), noted that typical engineering disciplines besides mechanical engineering included electrical, chemical and civil engineering. What was remarkable at that time was that all of these disciplines, although they were related to each other, relied on separate bases of knowledge, separate textbooks and journals, and postulated their own exclusive intellectual and professional domains. Today, this is different. The main reason for the ongoing integration of different engineering disciplines and knowledge bases can

primarily be traced to the changes related to the overall scientific and social domains that take place as a direct response to the information revolution. As a further consequence of this development, which might sound ironic according to Alciatore and Histand (2003), engineering has begun simultaneously focusing as well as diversifying.

To return to the review of the roots of mechatronics it is worth mentioning other technical details regarding mechanical engineering and how these form part of the basis of mechatronical engineering. Isermann (1999), describes the different steps that have led from the development of mechanical systems to mechatronical systems as follows: The typical characteristic of mechanical systems, according to Isermann (1999), is to generate a certain motion or to transfer force or torque. In order to direct mechanical systems they are equipped with feed forward and feedback control systems. These control systems are either supported without auxiliary energy; for instance, the fly ball governor, or with auxiliary energy that can be electrical, hydraulic or pneumatic and manipulate the variable that may be controlled with the help of the power amplifier. In cases where fixed wired devices are added, only very simple control functions can be operated. To achieve a much more precise, flexible and comprehensive control function, these analogue devices have to be replaced with digital computers. The essence of the development from the mechanical to the mechatronical system is, therefore, the integration of mechanical and electronic systems. Isermann (1999), adds that as a further feature to mechatronical systems, digital information processing can be added. Through the integration of these digital information systems more sophisticated control functions can be realised. Examples of these control functions are the calculation of non-measurable variables such as detection and diagnosis of failures, or when failures exist, the reconfiguration of redundant components.

Bishop and Ramasubramanian (2008), demonstrate the evolution of mechatronics in terms of the automobile, and highlight its prime role in today's product differentiation within the automobile sector. They describe that until the 1960s, the radio constituted the only electronic item within the automobile, while the main features were either purely mechanical or electrical; for instance, the starter motor or the electrical charging system (the battery).

Moreover, all engine systems were under the driver's control leading to a situation where the driver was responsible for selecting a specific spark plug to fire as soon as the fuel-air mixture was compressed, thereby avoiding optimal fuel usage. Through the combustion process it was discovered that there is an optimal time for ignition in order to achieve optimal fuel efficiency, which is dependent on load, speed and other measurable quantities. The discovery of the electronic ignition system in the late 1970s is regarded as the first mechatronical expertise or mechatronical system within automobiles.

Nowadays, other mechatronical systems within an automobile include the antilock brake system (ABS), which was introduced at the end of the 1970s and operates by sensing if the wheels lock and modulates the hydraulic pressure in such a way that skidding is either eliminated or minimised (Gissinger et al., 2003); or the traction control system (TCS), which was introduced in the 1990s to sense skidding during the acceleration process and to modulate power towards the locked wheel(s), and the dynamic yaw-moment control (DYC) which constitutes a method of controlling the vehicle's attitude (Sakai et al., 1999).

More broadly, mechatronics has also been closely associated with the development of robotics as an emerging engineering discipline (Fukuda & Kubota, 1999). In the latter 1970s, the central focus of mechatronics moved to the development of servo technology.

Servo technology was applied, for instance, within automatic door openers and vending machines. During the 1980s, when information technology was introduced,

mechanical systems were equipped with microprocessors to increase their performance. This resulted in numerically controlled machines and robots being more compact as well as automotive applications being more widespread. Through communication technology it was further possible to connect products in networks. An example of this new combination of mechatronics with communication technology deals with the possibility of the remote operation of robotic manipulator arms. Moreover, new and much smaller microscale sensor and actuator technologies could be implemented into products as well as developing new products. Examples of these microelectromechanical systems are silicon accelerometers that are used to trigger automotive airbags (Ashley, 1997). Since 2000, mechatronical products have advanced even further through processor speeds and advances in the development of high memory capacities that are found within car navigation systems, audio-visual consumer electronics, or passive and active safety systems, as well as through the recognition of nanotechnology and the integration of living and non-living molecules within processes and products (Habib, 2007).

Above all, it was pointed out that within the discipline of mechatronics there are currently two important observable changes. First of all, there is a tendency for applications that have been related to mechanical engineering to move into electronic engineering. An example of this is the development of devices related to playing music. Traditionally, there was the need for a motor to play records, this applied to playing vinyl as well as CDs. However, while there was the need for a transducer to spin a platter and another when a vinyl was played, this transducer became obsolete when the CD became a widely used substitute for records. Today, in the era of MP3 players, obviously there is no need for a transducer; but additionally, and more importantly, motors have now become obsolete for playing music. The other important change within the discipline of mechatronics is that the advances in

electronics have simplified the design of electromechanical systems as a result anyone can design them, even less experienced engineers are able to design more complex electromechanical systems; such as microprocessors or graphical software systems (Maloney, 2007).

When we look at further recent developments within mechatronical products of the early days of industrial robotics, we find that although robotics have advanced technologically over the years, there is still room for more improvements. At this stage, industrial robotics have been reported as only having achieved minor incremental improvements in production and assembly processes, and only primarily within the assembly of automobiles and electronics. To better understand what improvements can be expected in the future, one has to look more closely at its components. Industrial robotics have three main parts: The bone (linkages), the brawn (motive power) and the brain (intelligence). Through technological advances the first two aspects have been greatly improved over the years. For the future, however, the focus will be on the third aspect and this is expected to reveal a revolutionary progress. In particular, the primary focus will be on improved sensing and its associated artificial intelligence (Pinto, 2008).

4.3 Challenges within the development of mechatronical products and systems

Having learned about the multidisciplinary nature of mechatronics, it seems self-evident that the integration of the different elements and knowledge bases that have to be brought together for a successful development of mechatronical products and systems demands not only numerous integration efforts but is often problematic and costly, particularly in those cases where severe changes within the product and system development have to be made, even though the development phase is already in an advanced stage. To overcome integration challenges among those responsible for the development of mechatronical products and systems e.g. different ways of thinking and different vocabulary, the literature suggests that the experts from the different disciplines have to work in close proximity to each other; only this close interaction combined with the speed of the development process seem to make it possible to allow for the successful and timely market introduction of innovative products and systems (Abramovici & Bellalouna, 2007; Bolton, 2003; Zeifang, 2006). To put it in a broader perspective, the central challenge of the development of mechatronical products and systems deals therefore with its relatively high level of complexity which is, for instance, manifested in the integration of different experts or knowledge. Moreover, complexity is also evident within mechatronical products and systems themselves as well as the organisational setting in which successful mechatronical product and system development can take place.

Brown (2009), reflects that a further challenge in the development of mechatronical products and systems is that the different elements that have to be integrated have their own life cycles, and each of the elements influences the other elements. Brown (2009), especially points to the automotive sector in which 90% of all innovation is related to advances in software that must be matched to existing mechanical and electrical designs.

The Aberdeen Group (2008) (cited in Lennon, 2009), identifies that firms which are concerned with mechatronical product and system development typically face the following three challenges:

- Problems at system-level have to be identified at an early developmental stage,
- all design requirements are realised in the final product,
- before building prototypes the system product behaviour has to be accurately predicted.

4.3.1 The complexity of product development

Eppinger and Salminen (2001), suggest that there are three important domains required to study product development complexity: product, process, and organisation. The complexity of a product consists of its sub systems and further components. The same is identified in regard to these sub systems. Calvano and John (2003), point out that a system, or sub system respectively, is complex if it is not possible to predict its emergent behaviour by an examination of its individual parts. In other words, the system shows behaviours that cannot be anticipated through the analysis of the single system components or their summation (Calvano & John, 2003). The complexity of a process is reflected in its different sub processes and phases and is further manifested in its tasks, activities and work units. The complexity of the organisation consists of the split into teams and working groups down to individual assignments. Eppinger and Salminen (2001), emphasise that these domains are closely interrelated and interface with each other. In other words, if one of the domains is studied, predictions about the other two domains may be made. Moreover, the analysis of all three domains are reported to have an influence on the success of product and system development, for example, the analysis of the product domain may show module and sub system boundaries that are more effective; the analysis of the process may lead to streamlining and accelerating

the process, the analysis of the organisation may lead to system team arrangements that are more effective.

Within the following paragraphs the organisational complexity associated with complex product development will be reviewed in more detail and with particular regard to the mechatronics discipline.

Organisational complexity - challenge I: Integration of the mechatronical R&D function

As mentioned above, mechatronical engineering encompasses various different elements that have to be integrated in order to develop innovative technological solutions. This situation provides many challenges for the management of knowledge related to this new discipline; in particular, in terms of the organisation of its R&D function, and primarily raises the question of how the management of the firm can potentially manage integration between the various experts and knowledge needed, in order to develop new products and systems, in time to meet the demands of an increasingly competitive environment (Lennon, 2009). Comerford (1994, p.46) picks up on this debate and vividly summarises the most obvious origin of the problem that the management of the firm faces, with regard to the management of its R&D function ´[t]he world of engineering is like an archipelago whose inhabitants are familiar with their own islands but have only a distant view of the others and little communication with them´. Comerford´s (1994), observation fits well with the common methods of product development and design within traditional engineering areas. Preston (1993), explains that product development, traditionally, was mostly led by mechanical engineers, for the simple fact that most products were mechanical with the exception of the prime mover. Typically, the next step that followed the mechanical product development phase was the ´thrown over the boundary wall´ approach. This meant that in many cases after the mechanical design was completed, the product was thrown over the mechanical boundary to the electrical engineers

who were supposed to add their part to the mechanical development in order to make it function. The ´thrown over the boundary wall´ approach clearly does not work for the development of mechatronical products and systems (Thramboulidis, 2005). What are the options for the management responsible for the successful development of mechatronical products and systems wishing to create an organisational environment in which the expertise of engineers from different disciplines is integrated effectively?

Under the subheading of ´The how of mechatronics´ Bradley (1997), suggests that in order to support an organisational environment in which successful mechatronical development can take place effectively, the management of the firm typically has to emphasise three factors which are also intensively discussed in the KM literature: Communication, collaboration and integration.

- Communication is important because experts from different backgrounds often have very different forms of understanding and philosophies in terms of a particular technology; therefore, the management of the firm has to encourage the various experts to come together and ensure that they share a common understanding of the challenges and details within the product development process.
- Collaboration of the different experts who are involved in mechatronical development is important so that the firm can achieve, or guarantee its competitive position, within the market.
- Integration is important for eliminating internal competition and barriers between product and system development, as well as production, so that a form of open development within the firm is created.

Organisational complexity - challenge II: Life cycle design and concurrent engineering

Although mechatronics as a discipline is centred on the integration of its core expertise, that is its technologies and the relevant experts, the effective approach to product and system development requires the integration of more factors such as education, training, production technology, sales and marketing (Brown, 2009). Therefore, the literature underlines that the mechatronical approach to product and system development and design must adopt the rules that build the basis of concurrent, or simultaneous, engineering (Bradley, 2000). Concurrent engineering as a term was coined in the late 1980s by the US Defence Advanced Research Projects Agency (DARPA) which stated in Report R-338 that ´[c]oncurrent engineering is a systematic approach to the integrated concurrent design of product and their related processes including manufacturing and support. This approach is intended to cause the developers from the outset to consider all elements of the product life-cycle from conception through disposal including quality, cost, schedule and other requirements´. Concurrent engineering is closely related to simultaneous engineering which gained much attention within the US automobile sector. An example of this was the development of the Ford Taurus, and with it the extraordinary reduction in lead-time compared to previous projects. The primary concern of concurrent engineering and simultaneous engineering is to provide the firm with a competitive advantage through rapid new product introduction. To achieve this, it was necessary that the process to product development was to be conducted concurrently (Backhouse & Brookes, 1996).

Concurrent engineering is also closely related to integrated product development (IPD). IPD in most cases calls for the development of multiple integrated product teams (IPTs) and other functional support groups. The success of IPD is dependent on the integration of IPTs. But how does integration take place? Browning (1997), suggests nine

types of integrative mechanisms (IMs) that vary in their importance according to the specific parameters of the product development project.

Browning (1997) separates his nine IMs into two groups: (I) Integration enablers and (II) integration maintainers.

(I) Integration enablers

1. Systems engineering and interface optimisation

2. Improved information and communication technologies

3. Co-location

4. Training

5. “Town meetings”

(II) Integration maintainers

6. Manager mediation

A. Management hierarchy (“up-over-down”)

B. Heavyweight product managers (HPMs) or integrators

7. Participant mediation

A. Conflict resolution engineers (CREs)

B. Liaisons

C. Engineering liaisons (ELs)

8. Interface “management” groups and integration teams

A. Predetermined

B. Impromptu

9. Interface contracts and scorecards

In conclusion, the paragraphs above review important aspects of the development of mechatronical products and systems. In particular, they maintained that general mechatronical

development involves a high level of complexity that is manifest in the mechatronical products and systems themselves, but also in particular, in the management of their development phases. To tackle the complexity of the management of mechatronical development it was determined that the three factors encompassing communication, collaboration and integration must be taken into consideration by the management of a firm. Above all, in order to allow for a successful and timely market introduction of mechatronical products and systems it was identified that it takes an integrated management approach, which closely connects the different functions such as R&D, production and sales.

4.4 Federations relevant for the German mechatronical sector

The following paragraphs present two important federations relevant to the firms concerned with mechatronics in Germany. One of these sector federations, EUROM, is concerned with the representation of European firms. The other sector federation, SPECTARIS, is particularly concerned with the representation of German firms.

4.4.1 EUROM

In the course of establishing the European Community, EUROM, the federation of European precision, mechanical and optical sectors was founded in Brussels on 17th May, 1960. Its member associations are AFIF (Spain), AFOP (France), Agoria (Belgium), Assofoto (Italy), Assottica (Italy), BAREMA (United Kingdom), BHTA (United Kingdom), Fabrilabo (France), FFII and SEPIM (France), FME (Netherlands), GIFO (France), MS (Denmark), Photo Imaging Council (United Kingdom), SPECTARIS (Germany) and SPECTARIS Medizintechnik (Germany).

EUROM´s prime mission is the communication of the interests of its members towards the EU commission as well as other European, national and international institutions

primarily in the fields of commercial policy, sales promotion, collection of market data, R&D, regulatory affairs and public relations. Furthermore, a central focus of EUROM is to monitor the Commission and Council of the European Union in terms of their compliance with providing the guarantee of fair competition conditions within the member states.

EUROM consists of seven different branch committees:

- EUROM I ophthalmic optics,
- EUROM II optics, laser & laboratory instrumentation,
- EUROM III photography and video technology,
- EUROM IV precision mechanics,
- EUROM V measurement and automation technology,
- EUROM VI medical technology,
- EUROM VII contact lenses and contact lens care products (Eurom, 2008).

The key competencies of the MNC in the case study are related to measurement and automation technology which EUROM (2008) lists in branch EUROM V. In terms of a broad overview of this branch, EUROM (2008), states that the firms that are concerned with measurement and automation technology apply state-of-the-art technology to respond quickly to the needs of the process and manufacturing sectors. In particular, the primary concern of measurement and automation technology providers is their ability to develop and provide equipment, as well as production techniques, that allow their customers to improve efficiency, control scarce resources and to monitor the impact that specific actions of customers might have on the environment. As the most important areas of application of measurement and automation technology, EUROM (2008), lists the exploration of oil and gas, recovery and production, chemical and petrochemicals, mining and minerals, water processing, the control and monitoring of the environment as well as manufacturing automation as it is found, for

instance, in the automotive sector. Moreover, EUROM (2008), reveals that the measurement and automation technology branch is characterised by the rapid developments within sensor and transducer technology, digital communication, computing, information technology as well as dental and distributed control methodologies. EUROM (2008), states that through the ever-more demanding health and safety requirements and sustainable development demanded from environmental policies, combined with the need for progressive automation in the areas that rely on measurement and automation technology, sustainable international business opportunities for this branch arise.

4.4.2 SPECTARIS

SPECTARIS is the German federation for optical, medical and mechatronical technologies. SPECTATRIS was founded in 1881 and includes three main branches:

- Consumer optics,
- photonics and precision technology,
- medical technology.

The principal missions of the federation are to provide its members with lobbying, sector promotion, statistics and other research, technology consultation, research and export promotion as well as foreign trade marketing. In 2002, SPECTARIS was awarded the DGVM Innovation Award by the DGVM (German Society of Association Management) for its extraordinary achievements in the fields of federation management, representation of interests and marketing of its members (SPECTARIS, 2009).

4.4.2.1 Structure of the German mechatronical sector

SPECTARIS (2009), describes the German optical, medical and mechatronical sector as a sector dominated by small to medium-sized firms. Large firms are regarded as an exception.

Overall, more than half of all inventions may be traced to small and medium-sized firms in Germany; therefore, unsurprisingly, this also applies to the optical, medical and mechatronical sector. While the larger firms in the sector are identified as strong and often successful within their markets for many decades, and with having developed close co-operations with research and science, the advantage of smaller to medium-sized firms are reported to deal with their capability to provide special problem solutions. Training is identified as playing an important role across all firms regardless of their size. Approximately 70% of all member firms of SPECTARIS revealed that they are encouraging and facilitating training, and many of the firms train more than is mandatory. In 1998, 8% of all the employees within the firms associated with SPECTARIS were apprentices; a percentage that is much higher in comparison to the average quota of 5% in other sectors and highlights the importance of KM within the sector. This is especially important because most of the businesses in the sector are small or medium-sized.

SPECTARIS (2009), revealed in its sector report 2008 for the year 2007, that the total turnover of firms in the optical, medical and mechatronical sector amounted to € 41.9 billion. Overall turnover in 2007 was 7.5% higher than in 2006. This successful development resulted from the positive development of foreign business as well as a stronger domestic market. Domestic turnover amounted for € 17.33 billion, that was 7.0% higher than 2006. Export turnover amounted for € 24.57 billion, that was 7.9% higher than 2006. Total employment estimated for 2007 is 235.000, that was up 4.8% compared to 2006. The number of firms was at a similar level in 2006, amounting to 2.690.

The heterogeneous optical, medical and mechatronical sector is further categorised into the following sub branches:

- Ophthalmic branches,
- optical components branches,
- the analytical, bioscientific and laboratory equipment branches,
- the imaging and phototechnology branches and
- the medical technology branches.

The R&D quota, which is the proportion of total turnover spent on R&D, amounted on average to 9.4% but in some instances rose to 25%. 13.4% of all employees in the sector were employed in the R&D function.

The table below illustrates important reference figures split according to the different sector sub-branches. There is some overlap in data, because some firms serve more than one sub-segment. Nevertheless, the table is helpful to gain a better understanding of how the overall sector is structured and in what proportions in respect of total turnover, firms etc..

Table 6: *Fraction of the single branches in regard to the overall optical, medical and mechatronical sector 2007*

	Total turnover (€ x billions)	**Domestic turnover (€ x billions)**	**Export turnover (€ x billions)**	**Employees (x 1000)**	**Number of businesses**
Ophthalmic segment	3.77	1.85	1.92	21.52	150
Optical components segment	22.3	7.2	15.10	114.0	1000
The analytical, bioscientific and laboratory equipment segment	5.76	2.64	3.12	33.6	330
The imaging and phototechnology sector	10.0	7.6	2.4		100
The medical technology sector	17.32	7.19	11.13	94.7	1246

Source: SPECTARIS Brachenbericht 2008

4.4.2.2 The international dimension of the German mechatronical sector

SPECATRIS (2009), identifies that the optical, medical and mechatronical sector is a traditional sector with high technological standards. This has led to an excellent reputation of the sector that applies to consumer goods as well as investment goods like microscopic or inspection systems. The sector is particularly strong in export. Most customers are located in the developed economies such as the USA, the United Kingdom, France, Italy, Japan, Canada

and Australia. However, there are also growing numbers of customers within the former Soviet countries as well as within the emerging economies of the Asian-Pacific Rim.

4.4.2.3 The innovative capacity of the German mechatronical sector

Although mechatronical expertise has developed over several centuries, the sector can by no means be considered as a phase-out model. In contrast, mechatronical expertise is, as developed by the optical and medical technologies which SPECTARIS integrates, well known for its constant advancements. SPECTARIS (2009), states that the overall R&D quota of the sector is well above the average of R&D quotas across other sectors and sits approximately at an average of 6% of sales, but can in some cases, increase to approximately 25% of total sales. This sector-specific innovative capacity is the reason why it is very highly regarded as an important sector to maintain Germany's reputation as being a provider of innovative and top-quality products and processes in the future.

4.4.2.4 The main challenges for the future

As mentioned above, the sector enjoyed an increase in employees from 2006 to 2007, amounting to a total number of 23.500 in 2007. The number of associated firms also increased slightly during the same time period. This is a positive trend; however, as SPECTARIS, working in cooperation with a personal consultancy, discovered in a recent survey, all firms in the sector revealed that they are already experiencing the predicted shortages of supply of skilled personal. This challenge was reported to be the main challenge that the firms face within the next 5 to 10 years.

In conclusion, this fourth chapter provided an overview of the discipline of mechatronics. In particular, different definitions of what mechatronics actually is were introduced and its related scope was reviewed. The chapter further discussed the roots of

mechatronics as well considering some examples of mechatronical products and systems. Additionally, the development and design of mechatronical knowledge and products was explored as to how it raises various challenges for the management of firms. Last but not least, EUROM and SPECTARIS, which are two important sector federations, were presented in detail; in this regard, key figures and future expectations of the German mechatronical sector were identified.

5. RESULTS AND DISCUSSION

The following chapter combines the presentation along with a discussion of the results of the case study conducted as part of this thesis. The chapter is broadly structured into two parts. These two parts primarily reflect the two different levels of analysis adopted within the thesis: PART I presents the results and the discussion of the sub case study, conducted at headquarters' level, in the context of the MNC located in Germany. PART II presents the results and the discussion of the sub case studies conducted at subsidiary level in the Philippines, the USA and in India. Both parts are further divided into the main theoretical insights that emerge from the respective sub case studies. In particular, it is presented in what way these theoretical insights are grounded in the field research which was conducted according to the specific research questions.

PART I

5.1 The sub case study at headquarters level

The first comprehensive sub case study of the thesis was conducted at headquarters' level. The following paragraphs present a detailed overview, analysis and discussion of the primary and secondary data collected.

5.1.1 Results and discussion of the research questions at headquarters' level

The following paragraphs present the main theoretical insights which emerged from the sub case study at headquarters' level. In particular, it is presented in what way the theoretical insights are grounded in the field research which has been conducted in reference to the specific set of research questions. This structure serves as general reader guidance; however, there are also aspects presented and discussed below the single research questions that are not closely tied to the theoretical insights and research questions but are important for understanding the sum of the pieces of the case study. This approach fits well with the exploratory inquiry adopted within this thesis that was reviewed in more detail in chapter three.

THEORETICAL INSIGHT I

High dynamics in emerging economies forces the MNC to set up production and R&D functions; the latter because only R&D employees who are located on the ground understand these dynamics and are able to respond to them, in stark contrast to R&D employees who are located in an economy with less dynamics.

This theoretical insight is grounded in the data which was collected as part of the field research carried out to explore the first research question applied to the headquarters level. In addition to the discussion of how this theoretical insight is grounded in the data, the following sub parts present and discuss further important aspects that were revealed in connection with the first research question.

5.1.1.1 How do the types of knowledge that subsidiaries reverse to the headquarters differ?

5.1.1.1.1 Research question 1: results

To approach this first research question, two important results of the case study must be identified. Firstly, the following paragraphs review how thinking takes place at headquarters' level in respect of the organisation of its business network of subsidiaries. Secondly, as later on in the chapter, it identifies in detail how the studied subsidiaries differ in respect of the types of knowledge that they reverse to the headquarters. Subsequent paragraphs will concentrate on the Chinese and Indian subsidiaries, and will also discuss how the types of knowledge that they reverse to the headquarters differ from the time when they were set up by the headquarters, to the types of knowledge flows that they reverse when the initial set up and training phase was completed. The concentration on just two subsidiaries narrows down the research question allowing for more in-depth discussions of the results. Both the Chinese and Indian subsidiaries were primarily selected for the following two reasons: first of all, both subsidiaries have either been recently enlarged, or are currently growing in regard to their respective production and R&D functions, and therefore can be understood as major growth drivers for the overall MNC; secondly, they represent good examples of how knowledge recipients have turned into important knowledge senders. [1]

[1] A special note has to be added which explains why the Chinese subsidiary was included in the sub case study at headquarters' level although it was not selected as a case subsidiary in which field research was carried out. The main reason for including the Chinese subsidiary is that the sub case study at headquarters' level revealed the importance of the Chinese subsidiary as a knowledge creator and knowledge sender from the perspective of the headquarters´ management. By that time, the three case subsidiaries were selected and organisational and travel arrangements had been already made. Due to organisational as well as financial limitations, the case study was not expanded to the Chinese subsidiary.

How does the MNC organise its business network of subsidiaries?

In brief, the case study at headquarters' level revealed that the overall thinking in the MNC is closely related to the production process. The concept that emerged from the data is that it is the aim to offer and sell products on a global basis in such a way that the price of the products corresponds to specific market cost structures. To achieve such a consistency between product prices and market cost structures, the cost of production and the cost of product development must reflect specific market cost structures. To give an example, interviewee 5 pointed out:

"We know that when we intend to successfully sell a weighing product in China or India, the price of the product must be relative to what Chinese and Indian customers are able to pay for such a product. This price has an impact on the cost of production and of R&D that we are willing to set for this product in this economy."

With regard to these two economies, it rapidly becomes evident that it does not make sense to produce and develop a weighing product in Germany and to then export this product to China and India, because the cost of production and R&D are far too high in Germany when compared to the price that the product will sell for in the Asian economies. Across all interviews at headquarters' level, it became evident that this reality forced the management of the headquarters to shift production, as well as product development, to China and India so that the cost of production and R&D reflects the cost structures of these markets.

Two interviewees highlighted that this way of thinking was already developed in the 1990s when the management of the headquarters asked how to exploit new business opportunities abroad. Two important aspects of this concept dealt with the topics of: what to continue to produce in Germany, and what to potentially produce elsewhere in the world especially with regard to a shift of production to Asia, and what this shift of production would imply for the overall organisation of the different MNC functions.

To sum up, to be successful in particular economies the cost of production and R&D must correspond to specific market cost structures.

Additionally however, the field research reveals the idea that the development of local R&D functions besides new production functions is important for another reason. In the 1990s, when the decision was made to look for production sites abroad, the headquarters' management learned that it was not reasonable to seek production sites that operated in a similar fashion to that found at headquarters' level; the requirements were understood as having to match the local peculiarities of the economy in which they were intended to be realised. In other words, the management of the headquarters did not formulate key requirements in the same way as they are set in Germany, but in the way that they might be realised in an overseas local economy. For example, when the headquarters could not find local suppliers in an economy where a new production site was intended to be set up, and that were similar to the ones in Germany, it was necessary to develop a way to use the materials that those local suppliers were able to offer. These specific local supply chain arrangements encouraged the headquarters' management to develop local R&D functions in addition to its production sites. The main concern of the R&D functions were, initially, to find new ways of exploiting local supply chain arrangements that were available in such a way that the end product still met the specific quality standards set by the headquarters. In this context, interviewee 5 stated:

"When a particular glass, needed for constructing a wind deflector of a weighing product, was not available, we learned to accept that within the economy of the new production site the local glass could also not be cut as precisely as it could at home in Germany. Our R&D function on the ground in China had to make the best out of the resources available."

Using this same example, this meant that the local R&D function had to come up with a solution to construct the glass in such a way to adapt it to the particular glass that was

available. With this in mind, the local supply arrangements and general market peculiarities encouraged the development of a local R&D function. Moreover, as is the case with the R&D function at headquarters' level, R&D at subsidiary level is always regarded as a means to an end, which means that it is application-oriented.

From knowledge recipients to knowledge senders

The data collected across nine interviews reveals that the types of knowledge that are reversed from subsidiaries differ from the time particular subsidiaries were set up, and then after this initial set up and training phases are completed. The following paragraphs review the differences of the types of reverse knowledge flows in more detail by focusing on the Chinese and Indian subsidiaries.

To begin with, interviewee 3 summarised in this respect:

"In China and India, we mostly sell ´low end´ products. These ´low end´ products are also produced and developed within these particular economies."

To enable the production managers and engineers within the particular economies to start their own production and R&D functions, they were initially trained at headquarters' level.

Moreover, production managers and engineers from the headquarters visited the subsidiaries, in some instances for a length of time.

Interviewee 3 highlighted:

"We had to train our local employees and control operations. Moreover, we had to learn much more about the demands of our customers in China."

This applied particularly to learning about the high dynamics within these economies, where the speed at which products must adapt to changing economy conditions is high.

Especially in the case of China, but also to some extent in India, the category which emerged from the interviewees at headquarters´level is that the dynamics within the economies cause customers to constantly demand new and innovative weighing products. In this connection, interviewee 2 pointed out:

"What is especially important is that we must understand that the pressure to create new knowledge and competencies is completely different in an economy whose growth rate is around 1-2 % on an annual basis, or when one is very lucky 3%, rather than in an economy with growth rates of 7-10% on an annual basis and is, therefore, far more dynamic. Under these economic conditions it is most likely that demand for particular products, which integrate a particular bundle of knowledge, changes rapidly."

Concretely, this means that in many cases, products that no-one expected to sell within such economies three years ago are being sold today, whilst at the same time, products that were sold three years ago are no longer in demand. Therefore, any firm or MNC experiences much higher pressure to innovate within these economies, and only those firms and MNCs who understand these pressures, survive. The fact that a firm is successful with one product at a particular point in time does not necessarily imply that it will continue to be successful for long; it must constantly endeavour to make its product meet the rapidly changing demands of the economies. Should it fail to do so, it is out of that business.

The headquarters' management realise that the pressure to innovate is not easily understood at headquarters' level, as the processes to both innovate and find solutions usually take a much longer time, far *too* long to succeed in dynamic economies like China. For this reason, those employees must actively create knowledge on the ground in these economies because they are the people who understand the pressure to constantly create new products, or make existing products meet the changing economy demands and, to subsequently reverse and share this knowledge with the headquarters.

In summary, when the headquarters set up its subsidiaries in China and India, the types of knowledge that were reversed primarily dealt with knowledge about the particular markets. Principally this knowledge was gained and reversed by the German production managers and engineers of the headquarters who were sent out to the subsidiaries. After the initial set up and training phase was over, the subsidiaries continued on their own, without the production managers and engineers sent from the headquarters, to reverse market knowledge to the headquarters.

However, the education of the production managers and engineers, who were sent out from the headquarters, went one step further than learning market knowledge after the initial set up phase of the subsidiaries was over. What surprised the production managers and engineers was the speed at which the Indian developers, after setting up their own R&D function, were able to create their own knowledge, reverse and share this knowledge with the knowledge of their colleagues at headquarters' level. Through the knowledge sharing with their colleagues at headquarters' level, the Indian R&D developers were further enabled to create more new sophisticated knowledge on their own. One example of this knowledge sharing relates to a new terminal, one component of a weighing instrument, which had been originally developed exclusively for the Indian economy. Through the knowledge sharing and learning among the production managers and engineers sent out from the headquarters, as well as the management at headquarters' level, was identified as a potential terminal that could be integrated in weighing products for both the Indian economy and on a global basis. Although some alterations on the terminal had to be made according to various requests from different markets, the key terminal had been developed in India as a direct outcome of the ability of the Indian R&D function to create their own key knowledge, and to reverse and share this knowledge with their colleagues in Germany.

This example of the joint R&D effort between the Indian subsidiary and the German headquarters shows the close co-operation between them in regard to R&D, which is transformed into products that are internationally marketable; therefore, the production and R&D function in India are not exclusively concerned with alterations of expertise that they receive from their headquarters, but more with the creation of their own new knowledge that they reverse and share with the headquarters. A similar form of knowledge sharing and learning takes place between the Chinese subsidiary and the headquarters, who together successfully developed a range of weighing products tailored primarily for the Asian market. To enable effective knowledge sharing, the employees of the different R&D functions belonging to the MNC, work closely together in project-related teams. Through constant employee rotation these teams also work in close personal contact.

In conclusion, the case study in regard to this first research question reveals that in the initial phase after the set up of the subsidiaries in China and India, the major type of knowledge that was reversed, primarily dealt with market knowledge. Market knowledge was especially important for the headquarters' management to gain in order to tailor their activities to the market pecularities in these economies, and that meant exploiting the supply chain arrangements most effectively, to allow for the development of products that are tailored to specific customer needs within these economies. Soon after the initial set-up phase, the headquarters learned that the subsidiaries were able to reverse their own market knowledge, besides the economy knowledge reversed through the German production managers and engineers, and also knowledge in the area of R&D. R&D related knowledge, particularly in India, was quickly reversed after the initial set-up phase was over, an occurrence that was unexpected by the headquarters.

5.1.1.1.2 Research question 1: discussion

Because of the exploratory nature of the research approach, some of the aspects of the case study do not directly relate to the particular research question, but these proved to be important not only to answer the main research question of the thesis, but also constitute a contribution to the existing body of literature that does not identify these in detail. The following three paragraphs identify and discuss these aspects in detail and additionally, why the approach developed in chapter two with the first research question proved to be effective.

The influence of economic dynamics on product development in China

The basic concept related to the general way of thinking in the studied MNC demonstrates a typical trend, an expansion of activities to economies with high growth rates that MNCs, which are headquartered in the developed economies, and possess high-tech competencies, follow and which is well documented in the literature (Archibugi & Michie, 1995; Narula & Zanfei, 2005). The main reason for a development of this kind of thinking is clearly related to increasing competitive pressures, and the opportunities for growth, that economies like China and India offer to these MNCs. Chapter two identifies the increasing competitive pressures on MNCs in detail, and the case study reflects the arguments put forward by Dunning (2000) and Nohria (2007): MNCs face an increasing intensity and dynamics in competition, and this applies not only to the largest MNCs, which are the main focus in the reference literature, but also to more medium-sized MNCs, like the MNC in focus here. How MNCs specifically deal with these pressures will depend on different factors e.g. the sector in which they operate, the main markets they intend to cover and the different legal environments that they face through having activities in diverse economies. The case study identifies one specific way selected by the studied MNC.

What is notable in respect of this MNC is what encouraged the management of the headquarters to set up, and then to enlarge, its Chinese subsidiary. It had learned that only through a local presence in China with both production and R&D functions would it be able to react in a timely way to the high dynamics in this economy. The rapidly changing demands of its customers in regard to the products that are offered by the MNC and particularly constituted in such dynamics that are not found within a home economy.

There is an aspect that high dynamics in emerging economies forces the MNC to set up production and R&D functions; the latter because only R&D employees who are located on the ground understand these dynamics and are able to respond to them, in stark contrast to R&D employees who are located in an economy with less dynamics. This notion represents a novel theoretical insight and relationship that has not yet been identified in any literature.

In the broader sense, there is limited understanding of the innovative input of subsidiaries located in emerging economies belonging to a MNC that is headquartered in a developed economy, and its ability to create knowledge for the whole MNC. So far the literature mostly concentrates on the kind and amount of knowledge that subsidiaries in emerging economies receive from the headquarters located in developed economies, and the obstacles that they face when exploiting this knowledge successfully (Li & Hsieh, 2009; Wang et al., 2003). Although there are studies (Altenburg et al., 2008), that, taking a different level of analysis, explore how emerging economies like China and India develop from economies described as producers to innovators, the understanding of the innovative input that they provide to the headquarters located in developed economies in gaining a competitive advantage, is limited (Peng et al., 2007).

From knowledge recipient to knowledge sender: the example of the Indian subsidiary

Another aspect, which needs to be discussed further, relates to the particular research question of the types of knowledge that subsidiaries reverse to the headquarters. It considers the ability of the Indian subsidiary to start reversing R&D related knowledge to the headquarters, soon after the Indian subsidiary was set up by the headquarters. This aspect must be emphasised and discussed in different stages. Firstly, what is notable about this is that the headquarters' management did not expect the R&D function in India to engage in the creation, reversing and sharing of knowledge that could be integrated in products, and not only tailored for the Indian market, but with some adjustments for globally marketed products. In other words, the discovery of the ability of the Indian subsidiary to create and share knowledge with the headquarters came as a surprise to the headquarters' management. In line with the discussion about innovative input of the Chinese subsidiary to the overall MNC, the ability of an Indian subsidiary as a knowledge creator, and knowledge sender, has not yet been identified in the literature. What has been discussed in a broader context in detail, is how India, as a system of innovation, is able to allow for the emergence of strong software firms, which in many instances, rapidly develop into global players in their particular areas (Pradhan, 2007), and not how subsidiaries belonging to MNCs headquartered in developed economies are able to create knowledge.

Secondly, what is more significant is the relatively short time that it took the Indian subsidiary to transform from a knowledge recipient to a knowledge creator and sender. What actually constitutes a short time could not be established precisely when considering a specific time frame e.g. a month or a week; rather it refers to the time shortly after completion of the initial training phase of the production managers and engineers on the ground of the Indian subsidiary. The literature does not discuss time frames in relation to the process of how

subsidiaries transform from knowledge recipients, to knowledge creators and to knowledge senders. What has been gleaned from the results is that the Indian subsidiary was faster than the Chinese subsidiary to transform from a knowledge recipient into a knowledge sender.

A valuable avenue for future research will be to explore how Chinese and Indian subsidiaries differ in respect of the time that they take to become valuable knowledge creators and senders for MNCs headquartered in the developed economies.

The close relationship of knowledge creation and knowledge sharing

In the broader context of knowledge creation, and the ability of subsidiaries to reverse knowledge and engage in knowledge sharing with their headquarters, emphasis was placed where the field research reveals that the knowledge created on the ground of the Indian subsidiary was, in most phases, linked to the knowledge sharing that took place between the R&D function in India, and the R&D function at headquarters' level. Only the combination between knowledge creation and sharing allowed for a timely integration of this pool of knowledge into one product. Knowledge sharing in the context of the MNC has been widely discussed within the literature (Dyer & Nobeoka, 2000; Doz, 2006), as well as which sources lead to knowledge creation within the organisational context (von Hippel, 1988). However, the close relationship between knowledge creation and knowledge sharing in the MNC has not been studied in depth. The results of the case study suggest that both theoretical concepts are closely related to each other and, it is complex and most likely impossible, to study whether knowledge creation requires knowledge sharing or vice versa: always in regard to the headquarters located in a developed economy; subsidiary located in an emerging economy context, and with the aim to integrate a pool of knowledge into one product. This result can have the following managerial implication: if knowledge creation and knowledge sharing in regard to this specific headquarters and subsidiary context are related theoretical concepts,

then the headquarters must be aware that knowledge creation and knowledge sharing in, and with these types of subsidiaries, which is intended to lead to a shared pool of knowledge, requires that the headquarters releases and shares knowledge with its subsidiaries. At headquarters level, this kind of knowledge sharing always also means a potential loss of knowledge.

The results and the approach taken to engage with the research question

In chapter two, the approach was developed that the types of knowledge flows that subsidiaries reverse to the headquarters, are best explored and analysed according to the main functions that subsidiaries perform. This approach was derived from the following literature: in a broader context, the literature suggests that headquarters usually follow very different motives when setting up or acquiring their subsidiaries, and that their various subsidiaries can, potentially, be concerned with a variety of different functions and roles (Birkinshaw & Hood, 1998).

Moreover, Gupta and Govindarajan (1991), develop their theoretical concept of intra-corporate knowledge flows, which, to some extent, relates types of knowledge flows to the different functions which subsidiaries perform. Although the results reveal that one type of knowledge that subsidiaries reverse to headquarters is related to market knowledge that cannot be regarded as a function that subsidiaries have, the approach proved to be effective for two reasons when studying different types of knowledge: firstly, this approach reveals that the type of knowledge that the Chinese and Indian subsidiaries reverse to the headquarters relates to their R&D function; secondly, this approach revealed a potential reason why subsidiaries reverse distinct types of knowledge to the headquarters. The results therefore reflect the types of knowledge that subsidiaries reverse to the headquarters will depend on their relevance to the headquarters. Whereas R&D related knowledge, that the subsidiaries

reverse to the headquarters, is relevant to the headquarters, because the headquarters can incorporate this knowledge with its own knowledge and develop new products. In contrast, production related knowledge, a further type of knowledge that could potentially be reversed to the headquarters, is not reversed to the headquarters because it is obviously not relevant for them.

Section 5.1.1.4, analyses the reason why knowledge related to the production function, is not reversed to the headquarters, but is linked to the different particularities of production at subsidiary and headquarters' levels. In brief, knowledge related to the production functions located in China and India cannot be exploited at headquarters' level because production processes at headquarters' level are mostly characterised by high levels of automation, which need other types of knowledge in order to function effectively, in comparison to the production processes in China and India, where manual input is predominantly involved.

Although the case study primarily explores that two distinct types of knowledge are reversed by the subsidiaries to the headquarters, it also underlines the arguments made by Trott (2008), and Mudambi (2008), as reviewed in chapter two. They argued that the management of knowledge and innovation must follow an integrated approach – a management process combining different areas of knowledge and different management functions. Different areas of knowledge were identified according to the various subsidiaries and a variety of management functions were identified as the R&D functions, as well as the sales and supply chain functions, which may be closely related to the market knowledge that subsidiaries reverse to the headquarters. This integrated approach towards knowledge management seems to be especially important in the sector of mechatronics. In this respect, chapter four of this thesis points to the need for an effective combination of different layers of

expertise found in the various functions across firms and MNCs to enable them to react in a timely fashion to rapidly changing global market demands.

THEORETICAL INSIGHT II

The ´technology differentiation´ approach that the MNC developed can be linked to the way the headquarters manages reverse knowledge flows from its subsidiaries.

This theoretical insight is grounded in the data which was conducted as part of the field research carried out to explore research questions two to five applied to the headquarters level. The following sub parts present and discuss the individual research questions in detail and also demonstrate how the results of the single research questions are linked to each other; therefore, enabled to researcher to formulate the theoretical insight from studying the various real world conditions.

5.1.1.2 How do subsidiaries differ in regard to the nature of the types of knowledge that they reverse to the headquarters?

5.1.1.2.1 Research question 2: results

In earlier paragraphs, it was highlighted that the differences in the types of knowledge that the subsidiaries reverse to the headquarters may be differentiated between the initial set-up phase and the time when this phase is completed. However, differences in the nature of the types of knowledge that subsidiaries reverse to the headquarters can, predominantly, be associated with the key competencies that particular subsidiaries have. The allocation of particular key competencies to particular subsidiaries is part of the ´technology differentiation´ approach that

the headquarters develop in order to successfully manage its network of global subsidiaries and partners. This approach is mentioned here in connection with the research question at 5.1.1.4.

To outline the key aspects of this approach here: the ´technology differentiation´ approach particularly distributes the key technological competencies of the MNC in such a way, that all main locations with R&D functions concentrate on those technologies in which they are most advanced and experienced. One target of the headquarters' management is to allow for ´technology differentiation´, not only within its home market but also to integrate its business network of subsidiaries. In reference to the first research question, the general thinking of how to organise global activities focuses on the exploitation of local knowledge and the advantages of location-specific market cost structures. The ´technology differentiation´ approach fits this form of general thinking perfectly.

The key competencies of the subsidiaries and the nature of the types of reverse knowledge flows

The following paragraphs review the key competencies of those subsidiaries in which sub case studies were conducted: in the Philippines, the US and in India. Out of these three subsidiaries, the US and Indian subsidiaries have a variety of functions (e.g. human resource, sales, production and R&D), whilst the Philippine subsidiary only has a R&D function and a recently implemented sales function, which consists of only two employees. What all three subsidiaries have in common is that their key competencies primarily relate to the R&D function.

The Philippine subsidiary

The Philippine subsidiary is principally concerned with software development in the PC area. This software is subsequently integrated into weighing products that can cover a wide range

of applications. A concept emerging from the data is that software development in the Philippine subsidiary cannot be regarded as an activity that is performed in isolation from other R&D functions within the MNC. Therefore, close collaboration exists, along with reversing and sharing of knowledge, not only with the headquarters but also with the R&D functions in Hamburg and Aachen. The field research reveals in four interviews that the management at headquarters emphasises the active knowledge reversing and sharing process between the Philippine subsidiary and other R&D functions. In this context, interviewee 8 highlighted:

"We are well aware of the challenges that exist because of the geographical distance between Germany and the Philippines. Our ultimate aim is to create such a close relationship between the various developers involved that an atmosphere exists which is similar to one in which all developers would be jointly located in just one office."

A major task of this particular knowledge sharing process is to make sure that everyone in the relevant R&D function knows exactly what to do and at what time, and therefore the boundaries of both the staff and each R&D function is clearly set.

In the past, experiences revealed that shared R&D activities that are performed in geographical isolation are difficult to integrate and can incur additional costs. Extra costs means that some of the R&D activities performed in the Philippine subsidiary could not be shared effectively. Interviewee 8 emphasised in this connection:

"It happened that some of the activities could not be merged. What was done in the Phillippines did not complement the work of our developers in Germany."

The conclusion generated by the data is that the mismatch between the R&D activities conducted in the Philippines, and those in Germany however, is not a result of any lack of competency in the Philippine subsidiary, but actually relates to the fact that a great deal of

development had been performed in geographical isolation, this led to communication problems and a general misunderstanding of what exactly was expected of the R&D function in the Philippine subsidiary.

The US subsidiary

The key competencies of the US subsidiary are related to the area of water analytics and electrochemistry primarily to develop a pH meter and an O_2 meter. As discussed in depth later on in this chapter, the US subsidiary was not set up by the headquarters but was acquired. Before the acquisition, this US firm had, besides its expertise related to water analytics and electrochemistry, further key competencies related to weighing technology. However, after the acquisition, the headquarters' management decided to discontinue these key competencies. As interviewee 5 summarised the reason for the decision was:

"Actually today's US subsidiary was a former competitor. They were also providing weighing technology. However, we realised that their technologies were out-of-date and obviously this was not something we were looking for."

However, as highlighted at the beginning of this paragraph, the US firm had other key competencies besides its weighing technology related to water analytics and electrochemistry, which were of interest to the MNC. In short, what emerges is that the US firm was acquired because the headquarters' management knew that it could substitute its original weighing technology with the technology that the headquarters develops at headquarters' level and, additionally, could get access to its key knowledge in the area of water analytics and electrochemistry. Within three years, this newly established US subsidiary was able to provide all of its former products at a high standard, along with high quality weighing products, by the integration of the key competencies that came from the headquarters in Germany, and that lay in the area of weighing sensor technology.

In summary, interviewee 5 stated:

"*Our US subsidiary had to give up some of its former key competencies. The aim was that it focused much more on adapting some of our products to the particular demands of our customers in North America. What was also important was that it had to start concentrating on its technological competencies which are related to water analytics and electrochemistry."*

Its related key knowledge is reversed, and exploited at headquarters, and is also available in the form of products to other units within the business network.

The Indian subsidiary

Throughout the interview process, it was mentioned that the Indian subsidiary is regarded as a very young subsidiary both in respect of its production as well as its R&D function. The main reasons why it was set up by the headquarters were discussed earlier in this chapter. Although, one main activity of this subsidiary is to adapt existing products and technologies to the particular market demands in India, it also has its own distinct key competencies, and these also relate to its R&D function and deal with the development of electronics.

The field research reveals that the headquarters´ management, although it was surprised by the rapid development of competencies on the ground of the Indian subsidiary, must closely monitor these competencies and developments. Interviewee 3 reported in this context:

"*We know very well that our colleagues in our Indian subsidiary like to announce how their own capabilities allow them to engage in technological developments which are complex. In many cases, we could not find the quality that we were looking for.*

Close monitoring is needed from our side"

This observation does not suggest, according to the headquarters' management, that the R&D function would not be capable of providing the required quality of R&D in the future. The

headquarters' management sees the reason why the Indian R&D function announces its capability of performing new and more sophisticated R&D, although they do not have this capability as grounded in the peculiarities of the Indian culture. The data collected at headquarters' level suggests that for Indian R&D employees, it is difficult to admit that they are not able to perform specific R&D. They view the acknowledgement of not being able to perform certain tasks as set out by the headquarters' management as a personal disgrace. In Germany, the headquarters' management does not report this behaviour in its R&D function. In several interviews at headquarters' level it was suggested that this reaction may also be culturally-based: to state that one cannot do something because one lacks the capability to do so is, although no one is proud of such a circumstance, is not seen as a particular disadvantage or personal disgrace in Germany. In contrast, it is regarded as a strength to be aware of one´s own professional boundaries.

In summary, the research highlights that all three subsidiaries differ in the key competencies that they have and, accordingly, also differ in the nature of the types of knowledge that they reverse to, and share with, the headquarters, and in some instances also with the other R&D functions of the MNC. What all these subsidiaries have in common is that their key competencies, as well as their key knowledge that they reverse and share, are related to their R&D function. This circumstance can be related to the ´technology differentiation´ approach that the headquarters have developed and that will be discussed in detail later on. Last but not least, the paragraphs above concentrate on the differences in the nature of the R&D-related knowledge that they reverse and share. One significant point here is that all three subsidiaries reverse market knowledge to the headquarters. The nature of this market knowledge differs from subsidiary to subsidiary. The main reason why the nature of the market knowledge differs is that all of them have their own distinct, close relationships

with suppliers (in the case of the US and Indian subsidiaries) and more importantly with their customers (in the case of all three study subsidiaries), which provide the subsidiaries with distinct market knowledge. Suppliers and customers are part of the external environments that the subsidiaries develop. In PART II of this chapter the relationships between the different subsidiaries and their external environments will be analysed and discussed in detail, especially in regard as to how they constitute channels through which knowledge is shared.

5.1.1.2.2 Research question 2: discussion

The paragraphs above present valuable results in respect of the second research question. One key aspect that the case study identifies is the differences in the nature of the types of knowledge that the subsidiaries reverse to the headquarters that can be related to the key competencies that the subsidiaries have. This is regarded as a starting point for more detailed future research. Chapter two identifies the theoretical concepts of knowledge flow pattern and coopetion as a valuable basis to explore this second research question. The following paragraphs discuss the way in which the field research reveals results that relate to these concepts.

The different nature of the types of knowledge that subsidiaries reverse

The case study reveals that the nature of the types of knowledge that subsidiaries reverse to the headquarters differ according to their respective key competencies and not to the different functions that they hold. This result constitutes a key aspect suggesting a knowledge-based view of the subsidiary. Above all, this aspect is related to the literature which pointed, in a broader context, to the development that many subsidiaries have seen from being concerned with receiving and absorbing knowledge sent from the headquarters, to active knowledge creators performing more sophisticated functions, resulting in technological competencies,

which make subsidiaries more attractive to the headquarters in terms of their innovative input towards the overall MNC (Frost & Zhou, 2005; Hansen & Lovas, 2004; McEvily et al., 2004; Pearce, 1999; Shimizutani & Todo, 2008).

The results of the case study and concepts of knowledge flow pattern and coopetion

In reference to this second research question, chapter two identifies two theoretical concepts that were regarded as a valuable basis to explore the research question. The following paragraphs briefly present these theoretical concepts, and review and discuss the way in which the field research reveals results that can be related to these existing concepts.[2]

Knowledge flow pattern

Taking a broader perspective, the literature suggests studying differences of subsidiaries being primarily a sender or a recipient of knowledge on the basis of knowledge flow pattern. In this respect, Gupta and Govindarajan (1991), suggest studying the magnitude and the direction of knowledge flows based on a two-dimensional perspective to differentiate between four types of subsidiaries global innovators, which combine low inflows and high outflows of knowledge, integrated players who combine high inflows and high outflows, of knowledge implementers who combine high inflows and low outflows of knowledge, and finally local innovators who combine low inflows and low outflows of knowledge. The theoretical concept by Gupta and Govindarajan (1991) builds a valuable basis to explore and discuss the data which was collected to answer the research question.

In this context, the field research reveals that the direction of knowledge flows can be studied relatively easily, but to measure the magnitude of knowledge flows proves to be a more

[2] The results of the case study in reference to these theoretical concepts were not presented under 5.1.1.2.1 because they are closely tied to the discussion of the theoretical concepts of knowledge flow pattern and coopetion.

complicated task. The question that arises is what can be regarded as a high or low inflow of knowledge and a high or low outflow of knowledge respectively?

Moreover, while studying the magnitude of knowledge flows, it became clear that the magnitude of knowledge flows does not explore the quality of the knowledge flows sent from the sender to the recipient or vice versa. Based on this result, the case study is regarded as a useful source for modifying the existing theoretical concept of knowledge flow patterns as follows: the modified theoretical concept of knowledge flow patterns partly integrates the work of Gupta and Govindarajan (1991) and includes a quality aspect. Similar to the study of the magnitude of knowledge flow, the study of the quality of knowledge flows proves to be a complicated task. The modified theoretical concept includes the following characteristics:

Similar to the theoretical concept of knowledge flow patterns introduced by Gupta and Govindarajan (1991), the modified theoretical concept includes an analysis of the direction of knowledge flows. Adapted to the particular research setting of this case study, the direction of knowledge flows was studied in the subsidiary-headquarters context. However, this concept can easily be adapted to other contexts e.g. subsidiary-subsidiary context or unit-unit context. The magnitude of knowledge flows is not differentiated as high or low; it explores whether the headquarters, or a particular subsidiary, sends more knowledge flows to the respective other part. As mentioned above, besides the magnitude of knowledge flows, the modified theoretical concept also incorporates the aspect of the quality of knowledge flows. In respect of the study of the quality of knowledge flows, the literature does not provide a distinct definition of what the quality of knowledge flow actually means. Ambos et al. (2006), argue that within most studies, it would be indirectly assumed that knowledge flows are always beneficial to the recipient, and this could be misleading as it would also suggest that high amounts of knowledge flows would be perceived as especially beneficial for the recipient. In

other words, the magnitude of knowledge flows does not allow for an estimation of the quality of knowledge flows; accordingly, it cannot be the aim of any management to just allow for high amounts of knowledge flows alone. The definition of the quality of knowledge integrated in the modified theoretical concept of knowledge flow patterns is derived from Ambos et al. (2006), who studied the benefits of reverse knowledge transfers in the subsidiary-headquarters context, and define the benefits of knowledge transfers as the value of knowledge transfers as evaluated by the headquarters. In the modified theoretical concept developed and adapted to the specific research question, quality is therefore, defined as the value of the knowledge flows as evaluated by the headquarters. Taking all these characteristics of the modified theoretical concept of knowledge flow pattern into consideration, the case study reveals the following results:

The Indian and the US subsidiaries, are regarded by the headquarters as receiving more knowledge flows from the headquarters than they send to the headquarters. What applies to both subsidiaries is that this result relates partly because they rely heavily on the key competencies that the headquarters holds. The characteristics of these key competencies will be reviewed in detail later on; however, what must be emphasised at this stage is that the key competencies that the headquarters holds is technologically more sophisticated in comparison to the characteristics of the key competencies found within both subsidiaries.

In summary, there are less knowledge flows sent from the subsidiaries to the headquarters than vice versa, and the knowledge flows that are sent from the subsidiaries to the headquarters also benefit the headquarters less than the knowledge flows that the headquarters sends out to the subsidiaries. This tells us that the quality of the knowledge flows that the headquarters receives from the two subsidiaries is less than the quality that the knowledge flows that the headquarters sends to the subsidiaries.

The Philippine subsidiary differs from the two other subsidiaries. Here, the headquarters as well as the other R&D functions in Germany and the Philippine subsidiary engage in an equal amount of knowledge flow with each other. The main reason for this relates to the perspective of the headquarters to regard the Philippine subsidiary as an ´extended workbench´. What `extended workbench´ exactly means will be explained later on. In the same vein, the case study reveals that the knowledge flows equally benefit the headquarters as well as the subsidiary; thus they have a symbiotic relationship.

In summary, the modified theoretical concept of knowledge flow pattern is regarded as a practical way of comparing the headquarters with their various subsidiaries in respect of which of them sends more knowledge flows relative to the other one and how the quality of the knowledge flows differs. This theoretical concept is regarded as a valuable way to study the complexity related to knowledge flows mainly for two reasons: first of all, over the long-run, one could study changes in the magnitude and quality of knowledge flows e.g. initially while the headquarters sends more knowledge flows to a particular subsidiary, a particular subsidiary might at some time send more knowledge flows to the headquarters or vice versa. The same applies to the quality of the knowledge flows. Secondly, one could study how specific mechanisms influence the magnitude and the quality of knowledge flows sent from one to the other.

Coopetition

Tsai (2002), conceptualises that different subsidiaries are in a state of coopetition in regard to their ability to create knowledge, reverse this knowledge, and share it with the headquarters. Coopetition is conceptualised as a behaviour of being cooperative and competitive at the same time. This theoretical concept has not proved to be a valuable point of depature to explore the data. In brief, what could be learned was, from the perspective of the headquarters´

management, the subsidiaries are well aware of the reality that all of them specialise in different areas, and accordingly have different key competencies based on the different nature of their knowledge bases, but must share their knowledge with the whole MNC in order to gain a competitive advantage. Therefore, they all show cooperative behaviour to share knowledge with each other. Co-operation is regarded as the key ingredient to allow for an effective knowledge sharing process, and a timely integration of this knowledge within products, which respond to ever-changing customer needs. However, a competitive behaviour among the subsidiaries in respect of their ability to create, reverse and share knowledge was not discovered in the data. This result applies to both levels of analysis: at headquarters and at subsidiary level.

To sum up, the paragraphs above identify that a key aspect of the case study in respect of this second research question is that the nature of the types of knowledge that subsidiaries reverse to the headquarters differ according to their respective key competencies, and not to the different functions that they hold. The remaining paragraphs discuss the way in which the case study reveals results that relate to the theoretical concepts of knowledge flow patterns and coopetion.

5.1.1.3 In what way was the access to reverse knowledge flows from subsidiaries the reason for the headquarters to set up or to acquire particular subsidiaries?

5.1.1.3.1 Research question 3: results

The case study revealed that a variety of reasons exist why the headquarters decided to set up, or to acquire, particular subsidiaries. The following paragraphs explore the reasons why four subsidiaries: the Chinese, Indian, US and the Philippine subsidiaries, were set up or acquired in more detail. One of the reasons why particular subsidiaries were set up or acquired was the

potential access to knowledge as well as the opportunity to allow subsidiaries reverse knowledge to the headquarters. However, the field research identifies that this reason was also the main reason why a particular subsidiary was set up or acquired applies within the context of the MNC, primarily to the US subsidiary, but also, to some extent, to the Philippine subsidiary.

Reasons for the set- up of the Chinese subsidiary

The main reason why the headquarters set up its Chinese subsidiary was that it wanted to serve the Chinese market. Across the nine interviewees it became evident that Chinese law and the entire economic situation demanded that in order to serve the Chinese market successfully, a foreign-headquartered MNC had to set up a production site in China. The newly developed Chinese subsidiary initially received all components that were needed to produce a weighing product from the headquarters in Germany. This implied that the weighing product was completely developed and produced at headquarters first and then split into its components that were subsequently shipped to China. The main activity of the Chinese subsidiary was to assemble the weighing products by integrating the components sent from Germany. In this context interviewee 4 reported:

"*The main aim of the company was to exploit existing technologies in a new market. China is a major growth market. Therefore, we had to be there, but we were not going to China because we were hoping to find new technological competencies there.*"

Once the initial set-up phase of the Chinese subsidiary was over, the headquarters made the strategic choice to begin to source all of the major materials needed for the main components of its weighing products tailored for the Chinese market, in China, to maximize the degree of local content. However, there was one clear exception to this strategy, and this

applied to the component that is related to the key competence at headquarters level, which deals with the weighing system.

In this respect, interviewee 6 highlighted:

"It is not at all our intention to transfer the knowledge relating to our main technologies to China."

This strategy continues to be maintained and is not planned to be changed at any time in the near future.

In summary, in the case of the Chinese subsidiary, it was not the aim of the headquarters to set up this subsidiary to gain particular knowledge, or to take the opportunity that the Chinese subsidiary could potentially reverse its key knowledge to the headquarters. However, as mentioned earlier, although the access to knowledge was not the main reason to set up the Chinese subsidiary, it became a valuable knowledge creator in respect of the market knowledge that it created. Without this market knowledge, and especially the awareness of the very different dynamics of the Chinese market, the headquarters would not have been able to develop successfully in China. Besides its market knowledge, the Chinese subsidiary also reverses knowledge related to its R&D function that was reviewed earlier in the chapter. This type of knowledge was not a reason initially for the headquarters to set up the Chinese subsidiary, but it became not only cost effective but also provided a valuable supplement within the organisation of the overall R&D activities of the MNC.

Reasons for the set- up of the Indian subsidiary

The main reason for the set up of the Indian subsidiary was slightly different to the one in respect of the Chinese subsidiary. The biotechnology business that belongs to the MNC already had a production site in India along with free office space and room to set up new production activities available for the mechatronics business. Similar to the Chinese

subsidiary, what was evident across all the interviews was that the headquarters' management made the decision to set up a production site in India because of the general legal and economic situation, which was characterised by high import tariffs and taxes placed on foreign-headquartered MNCs who wanted to serve the Indian market. In more detail, interviewee 2 highlighted:

"Taxes and tariffs amount to 30%-50% on foreign products in India.
This circumstance constitutes a substantial barrier for us as for any other export-oriented MNC that is headquartered outside of India."

In other words, again as was the case in China, it was obvious that in order to successfully compete in the Indian market, the MNC had to produce in India. The R&D function in India was set up later, after production had already begun. As in the case of China, it was the strategic choice of the headquarters to maximize the degree of local content in India in order to avoid the disadvantages of relatively high taxes and tariffs. By now, the Indian subsidiary also had its own R&D function, which primarily developed products for the Indian market, and also globally as discussed earlier.

In summary, the evidence that emerged from the data proved that the main reason for the set-up of the Indian subsidiary was not related to the access to particular knowledge, or the prospect of reverse knowledge flows sent from the Indian subsidiary to the headquarters. However, similarly to the Chinese subsidiary, the access to particular market knowledge, as well as R&D related knowledge, has increasingly become essential for the whole MNC in order to maintain its economic strength.

The relevance of particular knowledge, and reverse knowledge flows, from the Chinese and Indian subsidiaries at the time the field research was carried out, increasingly reflects that an integrated R&D activity exists amongst the developers of the headquarters and the Chinese and the Indian subsidiaries. According to interviewee 5, this integrated R&D

activity is usually concerned with the following process: an idea is developed, for example, to collectively develop a product for the Asian region, because the subsidiaries become aware of a demand from their customers, which is not yet being met by existing products; an analysis is performed, taking into consideration the key competencies that can be found in each of the different subsidiaries, this analysis usually takes place at headquarters' level. The subsequent development phase is shaped in such a way that each subsidiary develops a product component for which it possesses key knowledge and competencies. Increasingly this integrated R&D activity not only focuses on products tailored for the Asian market but also for all other markets that the MNC covers.

Reasons for the set- up of the US subsidiary

As briefly identified in earlier paragraphs, the US subsidiary is the outcome of an acquisition by the MNC. The interviewees identified that the US subsidiary was a competitor of the MNC as it also provided weighing technology. However, besides its weighing technology it possessed a key competence in water analytics and electrochemistry. Interviewee 3 highlighted:

"We acquired this company because we wanted to use its production site in the US. We knew that we could exploit our own technologies. Moreover, its expertise related to water analytics and electrochemistry was interesting. We saw this expertise as something which could potentially strengthen our range of products."

In other words, the data revealed that one principal reason for the acquisition and development of the US subsidiary was access to knowledge and the prospect of reversing key knowledge to the headquarters.

Reasons for the set-up of the Philippine subsidiary

The Philippine subsidiary was acquired by the MNC. However, as interviewee 8 highlighted:

"This acquisition came as part of another major acquisition that the company made at the end of the 1990s, when it bought another company in Hamburg. The Philippine subsidiary was originally part of this company."

In the post-acquisition period, the headquarters management decided to keep and develop this subsidiary, and to integrate it in its wider network, especially within its overall R&D functions. Therefore, the acquisition of the Philippine subsidiary, although it was an indirect acquisition, was the result of the headquarters' request to gain access to specific knowledge which, in the case of the Philippine subsidiary, deals with software-related technical knowledge; and with the additional aim of allowing this subsidiary to reverse its key knowledge to the headquarters and to its other R&D functions in Germany, in order to exploit this knowledge within the overall knowledge base of the MNC.

In conclusion, the case study reveals that the potential access to particular knowledge, and the opportunity to let subsidiaries reverse knowledge to the headquarters, were not the main reasons behind the set up of the Chinese and Indian subsidiaries. However, by the time the field research was conducted, access to particular knowledge and reverse knowledge flows that are sent from both subsidiaries to the headquarters, constitutes an important input to the overall knowledge base of the MNC. This applies to market knowledge as well as the knowledge related to R&D, which both subsidiaries reverse to the headquarters. With respect of the US and the Philippine subsidiaries, the approach was different. In both cases, the subsidiaries were not set up by the headquarters, but rather were developed as a result of acquisitions. Both had key knowledge that was of interest to the headquarters, hence the potential access to this key knowledge, and the opportunity to allow these two subsidiaries to reverse this knowledge to the headquarters were the main reasons for the headquarters to maintain and develop these firms.

5.1.1.3.2 Research question 3: discussion

The paragraphs above present valuable insight into the field research at headquarters level. Some of the key aspects of this will be discussed in more detail. First of all, the access to knowledge and the opportunity to establish subsidiaries to reverse knowledge to the headquarters was not the reason why the headquarters set up its Chinese and Indian subsidiaries, but rather constitutes a positive side effect of the set-ups will be discussed in more detail. Secondly, the access to knowledge that was regarded as the outcome of an acquisition, was not a straightforward process for the headquarters' management, due to the fact that only some elements of the knowledge base of the acquired US firm were of interest to the MNC is discussed further. Thirdly, another relevant aspect that demands further discussion follows the discovery that the Philippine subsidiary was only added as a valuable creator and sender of reverse knowledge flows to the overall business network by chance.

The access to knowledge and reverse knowledge flows as a positive side effect? The example of the Chinese and Indian subsidiaries

That the headquarters management did not set up its Chinese and Indian subsidiaries for the reason of gaining access to particular knowledge or reverse knowledge flows reflects the literature (Kuemmerle, 1999). In respect of the more managerial reasons why MNCs that are headquartered in the developed economies, set up or acquire subsidiaries in emerging economies, the field research also reflects the main characteristics of the case sector which are, for instance, identified by the sector association SPECTARIS (2009). In general, the technologies that MNCs and firms of the case sector develop in Germany are considered to be highly sophisticated and innovative. To put it in a more abstract perspective, the technologies are predominantly regarded as the outcome of inventive talent and long lasting development work, which is possible through the availability of experts in the field who are continuously

seeking to develop and integrate innovative solutions for various customer demands. China and India are emerging economies.

One characteristic of being an emerging economy is that the education system and with it the availability of experts, with reference to the particular case sector studied, are not as developed as, for instance, in Germany. Nevertheless, the aspect that the Chinese and Indian subsidiaries, although they are embedded in emerging economies with all the associated shortcomings, are able to create their own knowledge, and reverse as well as share it with the headquarters, shows that a drive to learn and to develop certain technologies by themselves exists and this provides a thought-provoking desire, in terms of a discussion of their future ability, to offer technologies that are equally as sophisticated as those currently found at headquarters' level. For the moment, no-one is able to provide an answer to why this occurs and the opinions found among practitioners are very diverse. In general, MNCs headquartered in the developed economies cannot wait for the answer, they remain alert to maintaining the quality and innovative capacity of their technologies at headquarters level, and in order to remain competitive in this context, they must constantly upgrade their technologies and never become overly confident that they will never be overtaken by the technologies developed in their subsidiaries in the emerging economies.

Challenges of knowledge acquisitions: the example of the US subsidiary

The second aspect which should be discussed further deals with the acquisition of the US firm, which was predominately influenced by the fact that this firm had particular key knowledge related to water analytics and electrochemistry. In other words, the acquisition took place because the MNC wanted to take advantage of an existing production site, related to its own technologies and acquire a bundle of knowledge. The strategy of knowledge acquisition, to render its own knowledge base more valuable, is well documented within the

literature (Andersson & Forsgren, 1997; Forsgren & Pedersen, 1998; Moore & Birkinshaw, 1998). In essence, the extension of an existing knowledge base of a firm through the acquisition of another company is one key question that particularly concerned scholars of the resource-based view of the firm (Penrose, 1959; Wernerfelt, 1984).

In reference to the results presented under the latter research question, what is notable in regard to this knowledge acquisition is that it proved less easy for the headquarters' management to acquire, share and exploit knowledge in the area of water analytics and electrochemistry when the subsidiary was informed that its technological expertise in respect of weighing instruments was to be abandoned. How to effectively manage such a case in which an acquisition takes place when only particular elements of the knowledge bases of the acquired firm are of interest to the acquirer, has not yet been adequately explored in the available literature and could be regarded as a valuable avenue for future research.

Sender of reverse knowledge flows by chance: the example of the Philippine subsidiary

The third aspect that demands closer discussion relates to the Philippine subsidiary, which out of all the subsidiaries sends the most beneficial reverse knowledge flows to the headquarters, as well as the other German R&D functions, and was only indirectly acquired by the headquarters. The subsidiary that is studied was originally set up by another MNC acquired in 1999. What this demonstrates is that there are obviously opportunities for the MNC to access knowledge, and to find subsidiaries, who are able to reverse knowledge to the headquarters. The acquired MNC was able to set up its Philippine subsidiary to gain access to knowledge and have this subsidiary reverse its knowledge to the MNC. However, the MNC has not set up subsidiaries to gain access to any particular knowledge, or to let subsidiaries reverse their key knowledge, demonstrates that the MNC, compared to the acquired MNC which originally set up the subsidiary on the Philippines, has not been very active in seeking out such subsidiaries.

To sum up by applying a managerial perspective, the case study implies that, up to now, the MNC has not been actively looking for subsidiaries abroad who might constitute knowledge creators and senders of reverse knowledge flows for the headquarters; an exception to this observation is, partly, the acquisition of the former US competitor that was transformed into a subsidiary. For the future, taking into consideration that more and more economies will offer more attractive locations for the MNC to exploit local knowledge, and reverse and share this knowledge, is considered to be an approach that could open up new business opportunities for the MNC, although this approach will obviously increase the dependency on subsidiaries. The development of the Chinese and Indian subsidiaries from knowledge recipients to valuable senders of reverse knowledge flows should be understood as a sign of overall change in the global organisation of the MNC's activities. Additionally, the key competencies that the Philippine subsidiary, which was more or less added to the MNC network by chance, offer the overall business network a value and supports the headquarters' management to actively look to set up subsidiaries, or acquiring other firms, to benefit from the key knowledge that these can provide and reverse to the headquarters, or share with other subsidiaries and units of the whole business network.

5.1.1.4 How can reverse knowledge flows from different subsidiaries be managed by the headquarters?

5.1.1.4.1 Research question 4: results

The main management and strategic approach of the headquarters to manage reverse knowledge flows from its subsidiaries is closely related to the ´technology differentiation´ approach, which the headquarters' management developed as a response to the increasing competitive pressures that it has faced since the late 1990s. The following paragraphs review

this ´technology differentiation´ approach in more detail. In particular, it is assessed how this is applied in the German-Asian context, and how the approach was developed.

Moreover, the following paragraphs explore how the different labour cost structures found in Germany and Asia have encouraged the MNC to develop this approach. In this context, the key competencies that are held at headquarters level are also reviewed in detail. In particular, it will discuss why these particular key competencies are held at headquarters´ level, and will briefly review what happened to a competitor in Germany who moved their entire key competencies abroad. The remaining paragraphs examine how the headquarters' management facilitates the development of social ties of the subsidiaries with the MNC. To facilitate the development of social ties of the subsidiaries with the MNC is identified as a further important approach to effectively manage reverse knowledge flows from subsidiaries. Here, the Indian and Chinese subsidiaries are given as two examples.

The ´technology differentiation´ approach

The essence of the ´technology differentiation´ concept deals with the concentration on the sustainable development of the key competencies of the MNC, and with the spread of some key competencies, across the overall internal business network. Furthermore, other competencies, which are not key competencies, are allocated to external partners. In more detail and with reference to the German-Asian context, this approach incorporates a concentration at headquarters' level in Germany on the R&D function, focusing on monolithic weighing systems and sensor systems, a concentration of the production and R&D function, focusing on housings at subsidiary level in China, and a concentration of the production and R&D function focusing on electronics (not the metrological but the applicative form of electronics), at subsidiary level in India.

The allocation of particular key competencies to these sites was the result of analysis of the technological strengths that the particular sites developed over the years. In terms of the headquarters, interviewee 3 pointed out:

"We know our technological competencies very well.

All in all, they are based on many different development stages -

technical know-how which we created and combined over decades."

In the case of the Chinese and Indian subsidiaries, which are both very young in comparison to the headquarters, the decision in respect of what they must concentrate on has relied on the experiences that the management had had with these subsidiaries in respect of their ability to create specific technologies. The headquarters' management explicitly stated that, in the future, it is likely that the areas of technological concentration and competencies will be expanded in these subsidiaries. The case study reveals that the headquarters' management particularly emphasises the aim that the three different R&D functions work closely together. All subsidiaries are considered to be well aware that only by a close interaction of all sites, one common product can be effectively developed. Because of the dynamics in the Asian markets, time is further a key pressure that forces close interaction. Close interaction can be an elusive concept.

To explore what close interaction means in detail, the case study reveals that it is related to the following concept:

Interviewee 5 highlighted that:

"Although we have different R&D activties in different geographical locations, they are all centrally controlled and co-ordinated by us here in Germany."

Interviewee 8 added:

"We see the software development in Manila as an ´extended workbench´ of the headquarters along with our other German development units."

All in all, specific project teams are developed who focus on specific products or a product range.

Furthermore, employee rotations have proved beneficial for close interactions of the various R&D functions; primarily because they decrease misunderstandings relating to general miscommunication issues or cultural differences.

When and why was the ´technology differentiation´ approach implemented?

´Technology differentiation´ has been an important step for the headquarters' management in their efforts to react to the pressures and challenges that have arisen by the increasing international interdependence of markets. Secondary data revealed that the origin of this approach dates back to the 1990s, and in particular to the decision of the headquarters' management to give up its electronics unit that was based at headquarters' level in Germany.

In this context, interviewee 5 reported:

"At that time the overall economic situation was difficult. This was primarily characterised in a weak US Dollar, in comparison to the deutschemark, which had caused decreases in total revenues. Our reaction to the overall negative developments was the decision that, from a cost and total revenue perspective, it just did not make any sense to maintain the electronics in Germany."

For this reason, the headquarters' management sent two of its senior R&D managers to Asia to look for opportunities and potential partners to whom some of the electronics units might be outsourced. When the managers from the headquarters returned from Asia, they reported that outsourcing the electronics unit would not happen, instead they would adopt an approach of ´technology differentiation´.

Secondary, as well as primary, data revealed that the main driver for developing this approach goes back to one Asian partner who was selected as a potential supplier of future electronic components. Here, one of his senior managers convinced the managers sent from the headquarters that, in general, it made no sense to develop technologies in Germany to then convert these technologies into products in Asia. In this context, interviewee 5 highlighted:

"Our partner gave us the advice that if we intended to produce successfully in Asia, we should better think the Asian and not the German way."

What the Asian partner implied was that it made no sense to convert the technology developed in Germany that was aligned to cost-effective production processes, into products in a region where cost-effective production processes are not a priority, because the cost of labour is considerably lower than that in Germany. How these aspects of cost-effective production processes and labour cost structures in Asia influenced the headquarters'

management to follow their ´technology differentiation´ approach is reviewed in more detail within the following paragraph.

The implementation phase

Continuing with the review of the first experiences of the implementation phase of the newly developed approach, what emerged from the data is that there was a tense atmosphere at headquarters' level after the decision was announced that the electronics unit would be outsourced to Asia. Not only in the electronics unit, but employees across the firm feared losing their jobs and, at the same time, were astonished that the new suppliers were able to offer the same quality that they attributed to the work done at headquarters' level. What the case study reflects is that at headquarters' level there was an awareness and pride of the technological competencies, yet also a feeling of ambiguity of how to evaluate the technological competencies in Asia, combined with the fear of knowledge loss to the supplier in Asia.

The case study further reveals that the employees in the electronics unit continued to be concerned for their jobs at headquarters' level, even after the senior R&D managers returned from Asia and started to communicate their approach. Naturally, it took time to reactivate their trust in the headquarters' management. The main reason for this is obvious: the emergence of new possibilities to reduce production costs by moving production abroad, which did not only apply to the MNC, but which were also being discussed at other German-headquartered MNCs; the employees felt that the MNC could potentially be restructured in such a way that more and more production would be transferred to economies who offer a lower cost of labour compared to Germany. At first, staff continued to be unsettled because technologies that were developed at headquarters level could not be exploited in Asia because they did not fit the production processes.

Moreover, it was also difficult for the two senior R&D managers to come up with an alternative approach after the decision of the board of directors to outsource the electronics unit had been already finalised. Therefore, these managers demonstrated significant courage arguing against this managerial decision which, according to interviewee 5, could result in many staff being laid off. The task of these managers was also to motivate the electronics unit at headquarters' level, in order to keep the electronics production unit at headquarters' level in a sustainable way, which also meant that cost cutting was inevitable.

Differences in labour cost structures

As briefly touched on in the paragraphs above, the different labour cost structures in Germany and Asia have a strong influence on how the headquarters' management manages its business network of subsidiaries. In this context, interviewee 2 stated that:

"Our aim is to have production, as well as R&D based in all major markets that we intend to serve. Both are needed to allow for effective product adaptations, and to enable all of our subsidiaries to have the ability to develop their own competencies further."

In respect of effective product adaptations, production and R&D functions must offer a high degree of variation of the MNCs´ product portfolio (it offers thousands of different options and models of the various products) and must keep the option of the final variations of the product assembly in the home market.

Following this approach, the flow of commodities out of Germany to all three of its subsidiaries, is characterised as concentrated and standardised, while the variations of its products are performed locally by the various subsidiaries. This has the effect that the products, which are produced and developed in the subsidiaries, are adapted to distinct market characteristics and demand. For instance, in China the product expectations are completely different to those in Germany. In Germany, a relatively high cost of labour exists, the

consequence of this means that, there must be a high level of automation integrated into the products that are created at headquarters' level, as well as in all of the other German subsidiaries that are tailored principally for the developed markets. One simple example that the field research identifies: a weighing product for laboratory use has two doors that open and close, had been made originally for manual use in Western Europe, but which is now designed in a way that the doors can be automatically opened and closed. Usually, such a product contains either a switch that will be pressed, or a sensor, which is activated, in order to open and close the door. Together with all other integrated high-tech components, such an item constitutes a highly automated product that needs special handling and maintenance.

For example, Chinese customers would be delighted by such a product, particularly with regard to its technological realisation, but when the price of the product is mentioned, Chinese customers would either say that they do not have that much money, or that they are not willing to spend their money on such an expensive product. A discussion might ensue as to why the product is not purchased by the Chinese, one might question why the doors have been designed for automatic use, a development that simply raises costs and is not absolutely necessary, because customers are easily capable of operating the doors manually, or, for instance, the question of why the product has an integrated clock, this is not really necessary when most customers will have their own watch.

Why do these different perspectives on products exist? What became evident from across the range of interviews carried out at headquarters' level is that the cost of labour is much lower in China compared to Germany, and for that reason, the products do not have to have the same high degree of automation. It is particularly important for the headquarters' management to precisely establish customer expectations in regard to the functionality and quality of products in this area, and then to develop and produce the products accordingly in

the market that one intends to serve. Obviously, the headquarters could also develop and integrate these adaptations at headquarters' level; however, when considering the structure of the MNC, it is much more cost effective, to make these adaptations locally in the subsidiaries. To have production as well as R&D functions locally in all major markets that the MNC intends to cover, is also necessary so that all have the capability to develop their own key competencies.

´Technology differentiation´ and the nature of the key competencies at headquarters level

In respect of the key competencies that are held either at headquarters' or at subsidiary level, the case study raises the question whether one could determine whether one key competency is more difficult to develop than another. The question does not sound particularly technical, yet the answer revealed was a clear 'yes'. To visibly demonstrate the key competencies of the headquarters, which are regarded as the most technically sophisticated of all key competencies of the MNC, interviewee 5, placed standard scales for laboratory applications on the table.

Simplistically, these scales include the following components: a lower part of body, an upper part of body, a display (indicating device), a keyboard, a weighing system, electronic measuring equipment, a power supply pack and an outlet to transfer data, for example, to a printer. The components that are most difficult to develop and produce are the monolithic weighing system and the electronic measuring equipment. It is difficult because key knowledge is found within the processes of producing these components. The key competencies developed at headquarters are difficult to copy, and this relates to a distinct characteristic, interviewee 5 that German firms should, in general, always be conscious about, dealing with the fact that they have an extremely high degree of expertise and knowledge in technical areas.

In respect of the key competencies of the headquarters, he attempted to illustrate his argument by means of the monolithic weighing system first. He pointed out that in order to develop such a system one needs all of the process parameters. The system is cut out of one aluminium block in a complex process. This implies that even if one gets access to the machine that is used to cut this aluminium block, and has the component drawing or the computer-aided- design (cad) files, and is able to produce an item that appears similar to the monolithic weighing system that is used within these scales; they will not function. The reason being that, in order to produce a functional monolithic weighing system, one has to design the cutting process in such a way that it follows a distinct cutting sequence, distinct cutting and infeed speeds, and one must develop the cutting tools in order to cut such fine and precise structures as specified. Another substantial part of the key competencies is related to the material that is used within the production process of a monolithic weighing system. This particular material is a type of aluminium that is mostly used in the aviation sector. It is sourced by the headquarters so that it matches distinct criteria. In other words, the material used for the monolithic weighing system has features that are not observable in a straight forward way.

To highlight the knowledge that is related to the material used, interviewee 5 said:

"One can observe this material 1000 times, but one will hardly ever figure out the specific features related to the material which is used for the production of this weighing system."

There is a further difficulty related to the production of the monolithic weighing system: even if one is able to understand the distinct features related to the material, and also is aware of the process parameters used within the production process, the monolithic weighing system will still not function. This concerns the mechatronical element related to the monolithic weighing system, which is the combination of the weighing sensor with the electronic component and the software that is found in a chip. The mechatronical component

is necessary to handle distinct material effects such as creeping. Creeping is when one puts something on the scales and the display does not reflect the correct weight instantly, but shows how the correct weight is reflected by a process of slowly increasing weight measure. Creeping is not a desired characteristic in weighing; it is an effect that is material-specific, material tends to creep. All of the features of the monolithic weighing system and its related mechatronical components mentioned here constitute key knowledge that is held at headquarters' level.

However, to keep this key knowledge at headquarters' level in Germany relates not only to the fact that this expertise is found in Germany but also because of cost specific aspects. As mentioned above, the cost of labour is relatively high in Germany; therefore, to keep these key competencies in Germany, they must be integrated into the production process in such a way that they are combined with a relatively high degree of automation. For instance, this is one of the reasons why specific cutting machines are in use today. In the past, the block that is nowadays made from one piece, once included 120 different parts. These parts had to be manually screwed together piece by piece. The development process from the time the weighing system was made out of 120 parts, to today's weighing system that is made out of one single part, took several decades to produce and constitutes a multi-faceted accumulation of high-tech knowledge.

A glance at the competitors

It is the focus on these particular key competencies that differentiates the MNC from its competitors, and at the same time shows its commitment to Germany as a valuable location for high-tech developments. According to the interviewees 2 and 5, many of the competing MNCs have not made a clear commitment to Germany as the location where they keep their distinct key competencies. In many cases, these MNCs transferred their entire key

competencies abroad e.g. to China. However, in most cases these MNCs faced problems in maintaining the quality standards of their products.

Additionally, by the transfer of their key competencies abroad, they faced severe loss of knowledge to firms in China who began copying and imitating them. The following citation of interviewee 5 highlights the most unwanted outcome that can happen to any MNC after it relocated and lost its key competencies abroad:

"The firm across the street from our headquarters did not understand its key competence, it shifted it abroad, and one year thereafter, they went out of business."

Developing social ties with the MNC

Besides the ´technology differentiation´ approach, the data indicates that the headquarters' management is especially concerned with the encouragement of the employees in the subsidiaries to develop social ties with the MNC. In this connection, interviewee 9 said:

"I have learned a lot when spending time here in Göttingen. I always tried to implement a number of ideas in China that I absorbed here. And I will continue doing this. Over the years, Ihave developed close professional as well as social ties with my colleagues in Germany. This is very helpful."

The following paragraph reviews two concrete examples of how these social ties are built with a special focus on the Indian and the Chinese subsidiaries.

Two examples that demonstrate how the headquarters' management develops social ties of its Indian and Chinese subsidiaries with the MNC are:

In connection with a plan concerning a mutual R&D project, two developers of the Indian subsidiary, one developer from the Chinese subsidiary and a team of developers from the German headquarters met in Germany. To please the employees who came from abroad they were invited by their German colleagues and received small gifts. As a result of the

casual atmosphere a lot of personal information was exchanged. Later that day, when the German developers saw that the Indians were sitting with their eyes extremely close to the monitors of their PCs, they felt free to ask them why this was the case. The Indian developers were quite taken aback by the question and could not really provide an answer. The German developers offered to take their Indian colleagues to the local optician to have their eyes tested. The Indian developers agreed. The result was that they were both found to be nearsighted and were quickly provided with glasses. For the Indians this meant huge relief; but for the whole team it was a pleasant way to strengthen their social ties and the social links with their MNC.

In a similar project, developers from the Indian and Chinese subsidiaries also met at headquarters' level in Germany. As they had to stay over the weekend, the team at headquarters level made plans for social events over the weekend. While the managing director of the Chinese subsidiary, who was also visiting the headquarters at that time, suggested that he would take his employees on a trip to the capital of Germany, the Indian developers were supposed to go ice-skating at a nearby arena, sadly the project leader interfered and said that this would be too dangerous for his Indian employees as he was afraid that his Indian team members could break their legs and then his whole project would be delayed or terminated. Instead, a trip to an indoor swimming pool was arranged. However, upon arrival at the swimming pool, the Indians pointed out that they could not swim, which came as a surprise to their German colleagues, who all consider swimming as an activity that is taught in high school. Therefore, the Germans asked their colleagues from India if they would like to learn how to swim and the answer was a resounding yes. Thus, the developers went to the swimming pool together where the Germans and a swimming instructor taught the Indian developers how to swim, initially they even feared entering the water. After several

lessons, the Indians learned how to swim. As a consequence, the Indian employees were so delighted that they pointed out, on several occasions, to the headquarters' management that they would never forget what the MNC did for them. And they would be proud of the fact that they were able to learn to swim in Germany.

In conclusion, the paragraphs above discuss that the main management and strategic approach followed by the headquarters' management to manage reverse knowledge flows from its subsidiaries is derived from its ´technology differentiation´ approach. The main focus of the paragraphs above rested upon the review of the implementation of this ´technology differentiation´ approach in the German-Asian context. Moreover, it examines how the different labour cost structures found in Germany and Asia encourage the headquarters' management to develop this approach. In this context, the key competencies that are held at headquarters' level were also explored in detail. The remaining paragraph identifies how the headquarters facilitates the development of social ties of the employees in the subsidiaries with the MNC. The case study reveals that the encouragement of social ties with the MNC is regarded as another important approach to effectively manage reverse knowledge flows from the subsidiaries.

5.1.1.4.2 Research question 4: discussion

There are various aspects related to the ´technology differentiation´ approach that demand a closer discussion. To begin with, the aspect that the ´technology differentiation´ approach constitutes the main management approach of the headquarters to manage reverse knowledge flows from its subsidiaries, might be transformed into a theoretical insight, which has not yet been discussed in the literature. The following paragraphs discuss what advantages, and disadvantages, emerge by following this approach when managing reverse knowledge flows from subsidiaries.

´Technology differentiation´ as a management approach

The most important aspect that the case study reveals in reference to the fourth research question, is that the approach of the concentration of the key competencies that the MNC has, and the decision to arrange distinct elements of these competencies across its business network of subsidiaries, as well as to allocate other competencies that are not key competencies, to external partners, also reflects the management approach of the headquarters to manage reverse knowledge flows from its business network of subsidiaries. The ´technology differentiation´ approach is not discussed in connection with the management of reverse knowledge flows sent from subsidiaries to their headquarters in the literature. This link is a main theoretical insight that emerges from the case study.

The ´technology differentiation´ approach can, in some way, become linked to an ambidexterity perspective of the management of knowledge and innovation (Raisch et al., 2009; Rothaermel & Alexandre, 2009). Applied to the case of the MNC that was studied, this means that the headquarters´ management combines, with its ´technology differentiation´ approach, the exploitation of its own knowledge in new local contexts, and with the exploration of new knowledge at subsidiary level. The combination of this exploitation and exploration of knowledge results in an overall MNC that is able to respond to global and local market demands.

Advantages of ´technology differentiation´ as a management approach

The following paragraphs discuss the main advantages of the ´technology differentiation´ approach, and its related suitability to allow a headquarters' management to manage reverse knowledge flows from its subsidiaries.

To concentrate on the key competencies at both headquarters and subsidiary levels allows for a systematic exploitation of those peculiarities that the economies in which the

headquarters and the subsidiaries are embedded: the economy in which the headquarters is embedded has, when compared internationally, a relatively high level of cost of labour, it has an education system that develops experts who are capable of developing sophisticated technologies, it encourages knowledge sharing amongst academic institutions and firms to allow for a conducive atmosphere that encourages innovation. The economy in which the Philippine subsidiary is embedded is characterised by a relatively low level cost of labour when compared internationally, its education system offers a large pool of graduates in the area of software engineering, it has a population structure that is characterised by a high proportion of young people which, when combined with the education system, creates an attractive location for foreign-headquartered MNCs to exploit; the economies of China and India in which the further subsidiaries are embedded, are characterised by a low level of cost of labour when compared internationally, provide education systems that develop young experts, offers two of the biggest growth markets for the products offered by the MNC. In summary, the main advantage resulting from adopting the ´technology differentiation´ approach as the main approach to manage reverse knowledge flows from subsidiaries, deals with the systematic exploitation of key knowledge, as well as labour cost advantages that are offered within the network of the MNC.

A further advantage of adopting this approach deals with the high level of control that the management of the headquarters has over the management of reverse knowledge flows from its subsidiaries. This control is mainly executed in two slightly different contexts: taking the ´technology differentiation´ approach as the major management approach to manage reverse knowledge flows from subsidiaries, regulates the competencies that are developed and strengthened within each subsidiary. Because the competencies are closely related to the knowledge that is created at a subsidiary and then shared with the headquarters, the

headquarters' management also controls what knowledge is created where, and shared with, the headquarters. From a slightly different perspective, this form of control does not allow the individual subsidiary a degree of freedom to try new things that might be related to the competencies and knowledge base of the overall MNC, but not precisely to the competencies that the headquarters allocated to the specific subsidiary. Nevertheless, this form of control is presented here as an advantage. The advantage that emerges from adopting this approach is that the headquarters ensures that the creation of knowledge and competencies at the subsidiaries is concentrated, and thus most effective. However, this type of advantage can clearly also turn into a disadvantage, this will be discussed in detail later on.

The case study reveals that the control that the headquarters' management executes by adopting the ´technology differentiation´ approach as the main management approach to manage reverse knowledge flows from its subsidiaries, is also evident because the approach prevents its subsidiaries from having control of all the necessary knowledge to develop a product on its own. In other words, the respective subsidiaries are able to create knowledge and competencies uncoupled from the key knowledge held at headquarters' level. The keyword that was widely used in the interviews at headquarters' level was that the ´technology differentiation´ approach is regarded as a strategy to prevent the loss of knowledge. Thus the control that the headquarters' management holds is demonstrated by the reality that the creation and the sharing of knowledge and competencies is not only regulated at subsidiary level, but also in the way that subsidiaries never receive all the knowledge that is needed to develop a product by themselves.

Disadvantages of ´technology differentiation´ as a management approach

Adopting the ´technology differentiation´ approach as the main method to manage reverse knowledge flows from subsidiaries, also incurs some disadvantages.

First of all, dividing some of its competencies amongst the subsidiaries that must then be brought back together again in order to develop new products, raises a number of obstacles e.g. geographical distance, time differences and communication problems that can make the process of knowledge sharing among the subsidiaries and headquarters time-consuming and difficult. In order to overcome these obstacles, the case study identifies that the headquarters encourages its different R&D functions to develop new products in such a way that a conducive atmosphere exists among the different developers involved in specific projects, which resembles a feeling of sitting in one room, even though they are located in different geographic contexts. However, in order to create such an atmosphere, the developers must get to know each other in person; this personal interaction is mostly organised by employee rotations. Employee rotations always raise significant costs for firms particularly when employee rotations involve an individual employee who is sent to another location several times on a regular basis. In other words, while the exploitation of different labour cost structures is discussed as an advantage in regard to applying the ´technology differentiation´ approach as the main approach to manage reverse knowledge flows from its subsidiaries, this advantage can be, to some extent, offset by the disadvantages that this approach might also raise in terms of significant costs of rotating employees. Nevertheless, the case study leads to the conclusion that the costs associated with employee rotations are still deemed as lower than a situation where the competencies would be held totally in one place.

Secondly, a further disadvantage of applying the ´technology differentiation´ approach as the main approach to manage reverse knowledge flows from its subsidiaries, is that the subsidiaries always only concentrate their R&D related activities on distinct fragments of the overall product development process, a situation that, in many cases, causes frustration and a reason to leave the MNC among the developers who are generally interested in the whole

product development process. How this reality is evaluated by the developers in the different subsidiaries is beyond the scope of this particular research question. It will be identified in more detail in PART II of this chapter.

In summary, the paragraphs above explore the link between the ´technology differentiation´ approach, and the management of reverse knowledge flows from subsidiaries, constituting a key theoretical insight that has not yet been identified in the literature. The paragraphs above further identify that the link of both approaches raises advantages and disadvantages in respect of the management of reverse knowledge flows from subsidiaries.

5.1.1.5 In what way and why does the headquarters face obstacles when managing and exploiting reverse knowledge flows from its subsidiaries?

5.1.1.5.1 Research question 5: results

The following paragraphs analyse and discuss a variety of obstacles that arise when the headquarters' management manages and exploits reverse knowledge flows from its subsidiaries. Before identifying the different obstacles in detail, there is one short note on the obstacle that arises when managing and exploiting knowledge within the R&D function at headquarters' level. This obstacle relates to the difficulty of the developers to internally share what they know within their function. In the overall MNC context, this obstacle impacts on the management and exploitation of reverse knowledge flows from subsidiaries, because the management and exploitation of knowledge is already complex within the R&D function at headquarters' level, where the reverse knowledge flows sent from subsidiaries are shared and exploited, an initial and significant obstacle is faced by the headquarters' management when managing and exploiting knowledge flows sent from its subsidiaries. The focus on the R&D function at headquarters' level emerges from the result that much of the knowledge that is

reversed from subsidiaries, relates to R&D as reviewed earlier, and thus the management and exploitation of knowledge reversed from subsidiaries is particularly relevant to the R&D function at headquarters' level. In addition to the obstacle at headquarters level, the case study reveals that the main obstacle faced by the headquarters management when managing and exploiting reverse knowledge flows from its subsidiaries, deals with the phenomenon of product piracy. Product piracy is especially prominent in the Chinese, US and the Indian subsidiaries. The following paragraphs discuss various reasons why product piracy is a phenomenon, existing in the three named subsidiary markets, and also reviews the two strategies that the headquarters' management adopts to tackle and minimise product piracy. The remaining paragraphs discuss two further subsidiary-specific obstacles related to the management and exploitation of reverse knowledge flows, which apply in particular to the US and the Philippine subsidiaries.

Knowledge sharing at headquarters level

Before discussing obstacles that arise when managing and exploiting reverse knowledge flows from its subsidiaries, one note on the management of knowledge sharing at headquarters' level: chapter two identifies knowledge sharing as a principal activity related to the management of knowledge and knowledge exploitation, this must be reviewed. The case study reveals that knowledge sharing at headquarters' level is already a difficult process in itself without the additional challenge of sharing knowledge that is reversed from the subsidiaries.

During the interview with interviewee 2, he stated that within the R&D function at headquarters' level:

> *"I have never found one developer who particularly liked*
>
> *to share his or her knowledge with someone else."*

Therefore, to some extent, he only sees the obstacles that arise when managing and exploiting reverse knowledge flows from subsidiaries as being related to factors such as geographical distance and / or adequate levels of communication between the headquarters and the subsidiaries. The difficulty of the developers at headquarters' level is to share all their experience and knowledge with (an)other developer(s). In this context, all of the interviews conducted at headquarters' level reveal that knowledge is generally related to power and that this especially applies to the level of the individual rather than to the MNC-level or the headquarters-subsidiary context. In other words, the case study suggests that knowledge sharing within the R&D function at headquarters' level is difficult in itself, because the individual developer perceives his knowledge as power, and to some extent, always perceives knowledge sharing as a loss of knowledge and power.

Moreover, interviewee 5 stated:

"In general, developers are even more reluctant to share knowledge when the overall economic situation becomes more difficult and might cause the management to act globally in terms of reorganising R&D functions."

He stressed that in difficult economic times, when there are increased fears of jobs losses, and when the headquarters' management starts considering changes to its R&D strategies, these developers are even less willing to share their knowledge because of the fear that their knowledge could become ´lost´ to subsidiaries, particularly those located in Asia.

Taking a broader perspective, when reflecting on the overall context of the MNC, the president of the mechatronics business points to the Indian subsidiary and in particular to its R&D function, where he observed the opposite nature of knowledge sharing that he described in terms of the R&D function at headquarters' level. Here, the developers are reported to be particularly willing to share what they know; this observation does not only apply to the context of the internal side of the Indian R&D function but also to knowledge sharing of the

Indian R&D function with the headquarters. According to the president of the mechatronics business, what drives this willingness to share what one knows is related to a form of pride that the Indian developers express in respect of the fact that they work for a German-headquartered MNC, they feel proud to be associated with a high degree of engineering strength, and are therefore motivated to demonstrate what they know, and are able to create and contribute to the whole knowledge base of the MNC.

To sum up, the management and exploitation of knowledge within the R&D function at headquarters' level is already a difficult task internally. The willingness to share what one knows seems to be low amongst the developers. This becomes even more obvious when comparing their willingness to share knowledge with the willingness of the developers of the R&D function in the Indian subsidiary. That the developers at headquarters already find it difficult to share knowledge internally at headquarters' level has the following implication for the overall MNC knowledge management and exploitation: when the management and exploitation of knowledge already generates a substantial obstacle internally at headquarters level, it suggests that effective knowledge management and exploitation of reverse knowledge flows from subsidiaries will also be a substantial obstacle given that the reverse knowledge flows sent from subsidiaries are shared and exploited within the R&D function at headquarters level. In this context, PART II of this chapter will reveal how the subsidiaries evaluate the ability of the headquarters to manage and exploit the knowledge that they reverse to the headquarters.

Product piracy as the main obstacle when managing and exploiting reverse knowledge flows

After this short note on the obstacle that arises when managing and exploiting R&D related knowledge at headquarters' level, the following paragraphs highlight the phenomenon of

product piracy as the principal obstacle of the headquarters' management when managing and exploiting reverse knowledge flows from its subsidiaries.

The case study reflects that product piracy is generally regarded among ten interviewees as a phenomenon of systematic theft of ideas and knowledge. Taking a deeper interest in the exploration of why product piracy is particularly a problem in the Chinese, US and Indian subsidiaries, the case study suggests that the headquarters' management mainly relates the existence of product piracy in these subsidiaries to social as well as labour market peculiarities of the economies in which the subsidiaries are embedded. Taking a different perspective, product piracy was identified by nine interviewees as a phenomenon that is not found at headquarters' level in Germany and this non-existence was, in line with the context of the three subsidiaries, also related to the social as well as labour market peculiarities in Germany. In more detail, the majority of interviewees highlighted that while in Germany, employees in all functions but particularly in the R&D function are mostly employed in one firm over their entire career, this is by no means the case in China, the US or India. In this connection interviewee 6 emphazised:

"Abroad turnover of employees is really different from what we know from Germany; it is much higher than in Germany."

This high turnover of employees has caused a loss of valuable knowledge in the past for the MNC. Furthermore, a high turnover of employees accounts for the constant need to find and hire new employees. In the case of developers especially, this is costly for the MNC because newly recruited developers must be trained until they reach the same level of competency as the developers who left.

In the case of the Chinese subsidiary, interviewee 2 pointed out that besides the high turnover of employers:

"*Unscrupulousness exists to copy and steal technologies and knowledge.*

That seems to be a common practice no one feels guilty about."

Moreover, interviewee 2 adds that he was not the only one who gained this impression, his observation was confirmed by managers of other sector-related firms who point to the same problems that they face when dealing with their Chinese subsidiaries.

In summary, interviewee 2 stated:

"When I talked to our managers, they reported to experience that former employees express their pride in having had the opportunity to be trained within a German company when they applied for new jobs. They claimed that through their work experience they were able to do the R&D work without the support of their former employer."

The case study explores, that in respect of product piracy, and loss of valuable knowledge by the close integration of subsidiaries, there is no ideal solution to prevent this situation occurring. One strategy against knowledge loss is to ensure that in the case of weighing products, the key components (i.e. the weighing system) are developed at headquarters' level where the key knowledge and technology are held. Here, it emerged that the interviewees feel that knowledge loss and exploitation is slowed down or reduced within contexts external to the MNC than might be the case within its subsidiaries. Only certain key competencies such as electronics, housings or software, none of which alone might build a fully functioning weighing product, may be developed and produced in the subsidiaries. The aim of the MNC is to prevent subsidiaries from absorbing the sum of all key knowledge required to develop and produce a weighing product that is labelled under the name of the MNC. In other words, it is the configuration of the weighing product from many different components that allows the management of the headquarters to control the knowledge that is sent to its subsidiaries, as well as to manage the nature of the reverse knowledge flows from its subsidiaries.

One notion that became evident in the majority of interviews is that the management of the headquarters is aware that it may never hold a status that completely prevents the loss of valuable knowledge; yet the hope is expressed that the security barriers in place against loss of knowledge and expertise are not easily overcome.

Interviewees were clear that the potential loss of valuable knowledge must not be a reason of stopping knowledge sharing with subsidiaries, or to cease to motivate subsidiaries to actively create their own knowledge and strengthen their key competencies.

In addition to this internal strategy, secondary data indicates that the MNC has also joined a project called ´Innovations against Product Piracy´, this is a network of various firms and MNCs who are working in co-operation with two Frauenhofer Institutes to jointly fight against product piracy. Their method is to fight product piracy by encouraging firms to constantly develop and adapt innovative high-tech products that make it difficult for product pirates to imitate or copy. In particular, one strategy that arose through the co-operation amongst the partners of the project, is to advise firms to split their key competencies into different areas, and spread them around their different R&D functions. In summary, this project is understood as a proactive way of enforcing know-how protection.

Subsidiary-specific obstacles when managing and exploiting reverse knowledge flows

Although product piracy is the main obstacle that the headquarters management faces when managing and exploiting reverse knowledge flows from its subsidiaries, there are further subsidiary-specific obstacles that must be explained. The following two paragraphs discuss the obstacles faced in the context of the US subsidiary, which used to be a competitor before it was acquired by the MNC, and in the context of the Philippine subsidiary, which mainly consists of one function that is related to R&D in the area of software engineering.

The subsidiary-specific obstacle, when managing and exploiting reverse knowledge flows from the US subsidiary, relates to the difficulty of the headquarters' management to encourage the willingness of the R&D function to create and reverse its knowledge to the headquarters. The case study revealed that the headquarters' management attributes its difficulties in this respect to the fact that the US subsidiary is the outcome of an acquisition.

As a result of the acquisition, the headquarters' management reports, that the US developers had feared that they would be substituted by developers at headquarters' level, and that the newly established US subsidiary would serve primarily as a production site for the MNC. Moreover, because the headquarters' management communicated that the weighing technology of the former US firm was out-of-date, and was to be substituted by the MNC, and only the competencies in respect of water analytics and electrochemistry were of interest to the MNC, the developers of the US subsidiary totally lost their willingness to create and reverse knowledge.

To enable and reinforce the willingness of the US developers, the headquarters' management initiated clear communications that primarily mediated with the developers, encouraging them that although they had out-of-date technology within their weighing products, they had and were still able to create valuable knowledge in regard to water analytics and electrochemistry, which the MNC regarded as particularly important for its overall knowledge base.

When managing and exploiting reverse knowledge flows from the Philippine subsidiary, there are further distinct subsidiary-specific obstacles that the headquarters' management faces: the Philippine subsidiary creates and reverses predominantly R&D knowledge in the area of software-engineering. The management and exploitation of this software knowledge is heavily dependent on the Internet. Because of this, there is the constant fear that when using this medium, an outsider could gain access to this knowledge and exploit it for their own purpose.

Moreover, the case study reveals that the headquarters' management faces an obstacle when controlling the knowledge management and exploitation between the Philippine subsidiary, the headquarters and other German R&D functions. In the past, there have been

instances where not all parties involved knew the exact boundaries of their knowledge contribution, and thus knowledge sharing and exploitation became difficult.

In conclusion, the paragraphs above discuss the obstacles that the headquarters' management face when managing and exploiting reverse knowledge flows and that relate, to some extent, to the difficulties that the developers at headquarters have to share what they know. However, the main obstacle related to the management and exploitation of reverse knowledge flows sent from subsidiaries, relates to product piracy and linked with this phenomenon is the loss of valuable knowledge. The paragraphs present two strategies that the headquarters' management adopts in order to minimise this obstacle. Moreover, the paragraphs review two subsidiary-specific obstacles that occur when managing and exploiting reverse knowledge flows from the US and the Philippine subsidiaries.

5.1.1.5.2 Research question 5: discussion

The results in respect of this fifth research question at headquarters' level, which have been reviewed in detail in the paragraphs above, provide a number of aspects that justify a more detailed discussion. To begin with, the aspect that the obstacle that the headquarters' management faces when internally sharing knowledge within the R&D function at headquarters' level also causes an obstacle when managing reverse knowledge flows from subsidiaries, will be explained in more detail. Moreover, product piracy, which the field research identifies as the main obstacle that the headquarters' management faces when managing reverse knowledge flows from its subsidiaries, is discussed by reflecting the implications that product piracy might have on practitioners to organise its worldwide R&D functions. Besides product piracy, the case study further identifies that an acquisition can cause an obstacle for the headquarters' management when managing reverse knowledge flows. In this context, it will discuss how the aspects grounded in the case study can serve as a

basis for future research in this area. Last but not least, the aspect that the dependency on the Internet as a major knowledge and information exchange medium causes an obstacle when managing reverse knowledge flows from subsidiaries is reflected upon in more detail.

The obstacle of knowledge sharing at headquarters level

To begin with, it is remarkable that one obstacle of the management and the exploitation of reverse knowledge flows from its subsidiaries relates to the situation where the R&D function at headquarters' level is having difficulties internally sharing the knowledge amongst its different developers who, as reported above, mostly regard knowledge sharing as a loss of knowledge. This obstacle, which can obviously also be regarded as separate to the management and exploitation of reverse knowledge flows sent from subsidiaries is, however, reported to affect the management and exploitation of reverse knowledge flows. This link is predominantly grounded in the data: here, the difficulty that the developers at headquarters' level have when internally sharing knowledge was reported to cause willing reluctance to share and exploit reverse knowledge flows from subsidiaries.

This link reflects the literature, which in a broader context and in reference to the domestic firm, highlights that the management of knowledge and in particular the sharing of knowledge, which is one key element of the management of knowledge requires that an overall atmosphere of collaboration, co-operation and motivation to share what one knows exists amongst the employees of a firm in order to share knowledge effectively (Goh, 2002; Szulanski, 1996). As there is no atmosphere of collaboration, co-operation and motivation to share what one knows internally within the R&D function at headquarters' level, this also hinders the management and exploitation of reverse knowledge flows sent from subsidiaries.

Moreover, this link of a lack of effective internal communication within one function that has an insufficient form of inter-active communication of that same function with related

functions located in other nodes in the MNC network confirms, in a broader sense, the argument put forward by Harzing and Feely (2008), who identify language and communication barriers. These are a direct result of an increase in worldwide operations, and are identified as the major obstacles, in the transfer of technologies and knowledge within the headquarters-subsidiary context.

Product piracy as the main obstacle when managing and exploiting reverse knowledge flows

The result that the phenomenon of product piracy could be identified as the main obstacle of the headquarters' management, when managing and exploiting reverse knowledge flows sent from subsidiaries, constitutes a key aspect that has not yet been discussed systematically in the literature. Up to now, the literature only discusses product piracy in a broad context. For instance, Mc Donald and Roberts (1994), describe product piracy as a phenomenon that involves products that are copied and offered on the market without the permission of those who initially developed and manufactured it.

In the same vein, Mc Donald and Roberts (1994), also point out that to find a suitable description or definition of the phenomenon of product piracy is difficult as it encompasses various forms such as look or sound alikes and counterfeiting. One potential reason why the literature to date discusses product piracy only in a broad context might be related to the fact that product piracy, although it is not a new phenomenon, is an elusive concept. The development of product piracy as a problem for firms has existed for decades; however, that product piracy constitutes a major threat for customers and the existence of businesses has increasingly been a problem in recent years. Maybe this fact makes it less surprising that product piracy up to now has been more actively discussed in the media than in the literature. With reference to a German context, the media primary discusses product piracy as a threat by Asian manufacturers and vendors who copy or imitate products and technologies that have

been developed by German firms (Sueddeutsche, 2007; Welt, 2010). One key focus within these discussions is the potential risk that consumers might face from these copied technologies and products (plusminus, 2009).

Based on the fact that product piracy could be identified as the main obstacle of the headquarters' management when managing and exploiting reverse knowledge flows sent from subsidiaries, the following paragraphs discuss two implications that this could have for practitioners.

The first implication is that the decision of a MNC of where to set up and acquire subsidiaries that are intended to engage in knowledge creation and sharing not only depends on an analysis into which economy is most capable of offering the best suited experts, as well as environment to create specific knowledge, but also depends on an analysis where specific knowledge creation is most secure, 'most secure' means, in this context ,where specific knowledge that is created is not lost to outsiders who exploit this knowledge for their own purpose, and might offer products that are based on knowledge that actually belongs to the MNC. Whilst maintaining protection for the MNC against product piracy, knowledge creation cannot necessarily be allocated to specific subsidiaries and economies and this constitutes a major problem for the MNC.

The second implication of this aspect is that in the event of knowledge being created in subsidiaries where the phenomenon of product piracy was discovered in the past, the headquarters' management of the MNC must find ways to overcome this threat. One could initially argue that the most effective way to fight this threat would be to stop allocating knowledge creation to those subsidiaries that are known for facilitating product piracy. However, as the case study identifies, this approach is not necessarily economically beneficial to MNCs who are generally exposed to increasing competitive pressures that are

predominately reflected in pressure on product prices. In contrast, it appears that the reality for most MNCs, especially those that are related to high-tech sectors, cannot remain economically successful without having parts of their knowledge creation taking place outside their home economies and, to an increasing degree, in emerging economies such as China and India where the phenomenon of product piracy exists. In addition to the pressure to allocate knowledge creation outside the home economy, MNCs face the legal situation that up to now they are not adequately protected by international uniformed laws that effectively shield them against product piracy. In other words, MNCs are generally well aware that they must find ways to overcome this trend by themselves because they cannot depend on the help of a comprehensive law system.

The case study reveals that the main strategy that the headquarters' management of the MNC here adopts in order to overcome product piracy is that it specifies that the subsidiaries in which knowledge creation takes place, no matter whether a particular subsidiary has been associated with product piracy in the past or not, are never in possession of the sum of all knowledge needed for developing and producing a complete product. The sum of all knowledge is exclusively held at headquarters' level in Germany; and this constitutes a rigid decision, according to the interviewees at headquarters' level that will not be questioned, certainly not today and most likely not in the future either. The fact that subsidiaries only create knowledge in distinct areas that the headquarters' management allocate to them and that must be reversed and shared at headquarters' level has, so far, proved to be a valuable approach for the headquarters' management of the MNC. In order to minimise product piracy, however, taking the perspective of the subsidiaries, and this perspective is presented in detail in PART II of this chapter, raises particular concerns. A prominent concern deals with the situation where the subsidiaries report that to only create knowledge in certain areas can result

in a lack of motivation and, in some instances, in the loss of valuable developers who are dissatisfied at never creating and understanding a complete product.

An acquisition as an obstacle when managing and exploiting reverse knowledge flows: the example of the US subsidiary

Besides the main obstacle of product piracy, the field research presents two further subsidiary-specific obstacles, one of which relates to the US subsidiary and the other to the Philippine subsidiary.

In terms of the US subsidiary, it identifies that this subsidiary had been a competitor before the MNC acquired it, is perceived as an obstacle by the headquarters' management in terms of the management and exploitation of reverse knowledge flows sent from this subsidiary. More precisely, the obstacle relates to the situation where the headquarters' management feels that a lack of willingness to reverse the knowledge that is created within the US subsidiary exists, because soon after the acquisition, the headquarters' management insisted that some of the existing technologies of the US subsidiary had to be replaced by technologies that were developed at headquarters' level. Lack of willingness and motivation by the sender of knowledge to the recipient of knowledge is discussed in the literature (Gupta & Govindarajan, 2000; Szulanski, 1996); however, not in any detail in the context of the management and exploitation of reverse knowledge flows in the MNC.

With specific reference to the aspect that the obstacle of managing and exploiting the knowledge sent from the US subsidiary is linked to the fact that the US subsidiary was the outcome of an acquisition, there exists, in a broader context, some literature which picks out KM related challenges and obstacles in acquisitions as a central theme. For instance, Bresman et al. (1999), discuss knowledge transfers in international acquisitions that are in the post-acquisition period, and which they describe as immediately after an acquisition takes place,

are mostly characterised by a one-way transfer of knowledge from the firm that acquired another firm to the one that was acquired, but that this one-way knowledge transfer is, after some time, substituted by reciprocal knowledge transferring between both firms. The case study reflects this argument put forward by Bresman et al. (1999), in terms of the headquarters - US subsidiary context. However, with respect to the Philippine subsidiary, which was also the outcome of an acquisition that the MNC made, although the acquisition of this subsidiary can be described as an indirect acquisition because it resulted as a consequence of the acquisition of another MNC that the MNC made in Germany, and to which the Philippine subsidiary used to belong, the argument put forward by Bresman et al. (1999), was not reflected; from the beginning, which Bresman et al. (1999), identify as the post-acquisition period, the Philippine subsidiary engaged in reciprocal knowledge transfers with both the headquarters and the other German subsidiaries. The fact that the Philippine subsidiary was indirectly acquired, might be one reason why there has been a reciprocal knowledge transfer between the subsidiary and its headquarters; however, one might also believe that there have been other reasons leading to this situation as well. A discussion around these potential reasons is beyond this thesis; however, the acquisition of a firm does not always automatically lead to a post-acquisition period, where the acquirer predominately transfers knowledge to the firm that is acquired, and that reciprocal knowledge transfers is a phenomenon that emerges over time, but reciprocal knowledge transfers may also take place in the period immediately after an acquisition took place, constitutes a relevant basis that could potentially inform future research.

The loss of knowledge via the Internet as an obstacle when managing and exploiting reverse knowledge flows: the example of the Philippine subsidiary

The field research reveals that the Philippine subsidiary is concerned with the development of software. This software is reversed and shared with software that is developed in Germany. Because of the geographical distance that makes regular face-to-face contact between the developers from the Philippines and Germany costly, and therefore difficult to arrange, most of the knowledge / development work is shared and exploited via the Internet, a fact that exposes this knowledge to the risk of becoming a victim of harmful exploitation by an outsider who might access this knowledge because the Internet is well known, although there are attempts to ensure against risks of access by outsiders, who are not to intended to be the recipients of particular knowledge, that it offers much room for illegal access. The result that the potential unwanted access of an intruder, and in this vein, the potential loss of knowledge, constitutes an obstacle within the management and exploitation of reverse knowledge flows sent from subsidiaries is an insight that has not been discussed in the literature.

Again, and in line with the discussion on potential ways to overcome product piracy, it must be said that not facilitating knowledge creation in the Philippine subsidiary may not be regarded as the right approach. Once again, the headquarters' management could clearly overcome the obstacle of the potential for losing knowledge to an outsider by not facilitating knowledge creation and the reversing of knowledge from the Philippine subsidiary; however, the potential risk to lose knowledge to an outsider must be accepted because not creating and reversing knowledge from the Philippine subsidiary at all would constitute a bigger economic loss.

In conclusion, the field research reveals a number of important aspects in connection with the obstacles that the headquarters' management of the MNC faces when managing and

exploiting reverse knowledge flows from its subsidiaries that have not been systematically discussed in the literature. Above all, the following paragraphs summarise the ways in which these aspects might inform future research:

It identifies that the obstacles may relate to the headquarters' level where the knowledge that is reversed from the subsidiaries is exploited. Here, it explains that the lack of willingness to share knowledge among the developers at headquarters' level has an effect on their willingness to share and exploit knowledge that is reversed from subsidiaries. Moreover, obstacles may also relate to the subsidiary level. At subsidiary level, knowledge loss in the form of product piracy was discovered as the main obstacle when managing and exploiting reverse knowledge flows sent by the subsidiaries. The central focus was on product piracy in the Chinese, US and Indian subsidiaries. Up to this point, product piracy has only been discussed in literature in a broad context. Because the case study reveals that it constitutes a major threat for the MNC here as well as for MNCs specialising in high-tech in general, it is suggested that future research is needed in order to explore this phenomenon in more detail. In particular, it is regarded to be valuable to identify the strategies, the paragraphs mention those which the MNC in focus adopts, are especially effective in order to minimise the loss of knowledge as a result of product piracy.

A further aspect revealed by the results in regard to the fifth research question, which is regarded as a valuable basis for further study, deals with the obstacle that the headquarters' management faces when managing and exploiting reverse knowledge flows from the US subsidiary, which they relate to the fact that the US subsidiary is the outcome of an acquisition. How an acquisition affects the management and exploitation of reverse knowledge flows that are sent from a firm that was acquired to the acquirer could not be studied in detail. The results that the case study reveal provide a mixed picture in this respect:

with regard to the situation where the US subsidiary was the result of an acquisition affected the management and exploitation of reverse knowledge flows, sent from this subsidiary to the headquarters became an obstacle due to the reluctance of the US subsidiary to engage in reverse knowledge flows. Whereas the Philippine subsidiary, which was also the result of an acquisition, did not affect the management and exploitation of reverse knowledge flows by the headquarters' management in any way, quite the reverse in fact, from the outset, the Philippine subsidiary willingly sent reverse knowledge flows to the headquarters.

Finally, one obstacle in the management and exploitation of reverse knowledge flows relates to the fact that an outsider might gain access to knowledge that is intended for sharing and exploiting over the Internet; this is a valuable aspect which has, up to this point, not been explored in any literature. To explore how MNCs can protect themselves against the risk of losing valuable knowledge via the Internet to an outsider, who should not be the recipient of the knowledge, is regarded as a valuable field of research that could help practitioners particularly to overcome this threat.

PART II

5.2 The sub case studies at subsidiary level

The following paragraphs present the overview, analysis and discussion of the primary data collected as part of the sub case studies carried out at subsidiary level in the Philippines, the USA and in India, beginning with a review of the history and the profile of the respective subsidiaries. The remainder of the paragraphs review the analysis and discussion of the primary data that is structured and presented according to the key theoretical insight and three sections which altogether cover the specific research questions each related to the research objectives set out for the subsidiary level in chapter one of this thesis.

5.2.1 History and profile of the Philippine subsidiary

As briefly touched on in PART I of this chapter, the Philippine subsidiary was initially set up by another MNC and was acquired by the German MNC in the late 1990s. Although it was not the headquarters' management of the MNC that set up the Philippine subsidiary, it quickly realised after the acquisition that this Philippine subsidiary could constitute a valuable supplement to its other activities in Asia. For this reason, the headquarters' management has significantly increased the number of employees over recent years.

Today, the Philippine subsidiary's main objective is the development of high-quality software development for process and laboratory applications, standard software packages for individual applications, and multimedia services. The Philippine subsidiary has continuously developed itself to become an important provider of software in the PC area, with a superior case but not in the embedded area. In respect of these two different types of software, the MNC differentiates software that is integrated within control modules, which is PC-related software and similar to software found in the Office package, and embedded software which

is a device specific software, embedded in the device, within an electronic component. For instance, this software is responsible for the computer to start up and enables the computer to recognise that it is a computer, and that the computer is available for programming. Initially, it was the intention of the headquarters' management, that there would not be any software development in the area of embedded software at the Philippine subsidiary. What was the reason for this decision? One of the key competencies of the German subsidiaries lies within the area of embedded software, and it is the aim of the headquarters' management to protect this key knowledge as much as possible. Therefore, software development in the embedded area is, for the most part, kept within the home country.

Another reason why embedded software is not developed to a significant extent in the Philippine subsidiary, relates to the lack of hardware local to the subsidiary because the Philippines itself is not a market where sales revenues are high in regard to the products offered by the MNC. In other words, because sales of the products such as weighing instruments, check weigher and metal detectors are low, there is no reason to have the hardware available local to the Philippine subsidiary. And because the software engineers do not have access to this hardware, they are not able to study a hardware application in detail. For the development of embedded software, software engineers usually need a lot of devices to study how the devices behave in the long run. Therefore, it is easier to develop software that is settled at a superior case and not dependent on significant numbers of hardware components. However, more recently, the situation is changing. There is also one software development project in the embedded area conducted jointly with the Philippines. This is a sign of the increasing trust that the headquarters and other German subsidiaries have in the Philippine subsidiary. Moreover, from the interviews that were conducted at both levels of analysis, the headquarters' level as well as the subsidiary level, identify that this project is not

intended to be a one-off, but more importantly is seen as a starting point for more projects of this kind in the future. By the time the case study was carried out, the software engineers in the Philippine subsidiary were taking part in three out of five key MNC projects of software development.

Moreover, all of the software development in the Philippine subsidiary is performed exclusively for the headquarters and other German subsidiaries. Until now, there is no software development conducted in this subsidiary for local customers in the Philippines. Besides the R&D function, there is also a small sales function that sells products of the MNC that are mostly developed, as well as exclusively produced, outside the Philippines for the Philippine market. By the time the case study was carried out, the Philippine subsidiary employed 22 members of staff, of which 18 were software engineers.

In a nutshell, since the time the headquarters' management gained access to the Philippine subsidiary, from the perspective of the headquarters' management, it has constituted an attractive opportunity to continuously reduce the high R&D costs related to software development in Germany. Above all, the Philippine subsidiary is being seen as constituting a way of offshoring software development within the same MNC, but to a subsidiary that is located in an economy where good education exists in the area of software engineering, and has a large pool of young expert staff who, quite importantly here, also speak fluent English. Last but not least, the Philippine subsidiary is also regarded as a facilitator to strengthen the presence of the MNC in south-east Asia.

5.2.2 History and profile of the US subsidiary

As part of the expansion of its mechatronics business in North America, the MNC acquired a Colorado-based firm in the late 1990s and transformed it into a subsidiary. Besides this subsidiary, the MNC has had other subsidiaries and further activities in North America since

the mid 1970s. At first, these subsidiaries and activities have been exclusively related to filtration products that are a key focus of the MNC's other core business that it has besides its mechatronics business. Since the beginning of the 1980s they were also concerned with both laboratory and industry weighing products.

The US subsidiary is a firm that was originally founded in 1880. Its inception was, most likely, a direct response to the Colorado gold rush, more precisely, it is recorded that during the time of the Colorado gold rush analytical scales were not produced in North America; thus they had to be imported from Europe. An English immigrant took the opportunity to begin to develop short-beam analytical scales at a small firm in Colorado. By the time the MNC acquired the Colorado firm, the firm primarily produced scales and electrochemical as well as moisture analysers, which were mainly targeted at laboratory applications and, to a minor extent, for industrial applications.

The strategic decision behind the acquisition of this firm was that the MNC realised that the North American market constituted an important growth market and was an essential driver in the MNC's overall global expansion. However, it was also assessed that North America was significantly different from its other main markets in Europe and Asia and that the MNC would only be able to meet the demands of the North American customers if it was able to provide them with products that are produced locally and maintained by local technical services according to their specific needs.

Some months before the field research was conducted, the US subsidiary was extensively expanded. In more detail, the existing facility was enlarged by 150 % of its original size at the location where it was first located, by adding a complex that includes new offices and additional space for its production and assembly functions, primarily related to

laboratory, as well as industrial, weighing products. Today, the US subsidiary has approximately 70 employees.

The US subsidiary covers the assembly and adaptation of the MNC product range in the areas of laboratory and industrial weighing products.

To sum up what was introduced above, having assembly and production functions on the ground of the North American market allows the MNC to respond quickly to the home customer demands and needs. Moreover, the US subsidiary has a R&D function concerned with the development of electrochemical measurement, e.g. pH-meters, conductivity, as well as ion analysis and moisture analysis, as well as dealing with calibrated mass standards. The US subsidiary offers technical support and possesses a sales and marketing function that are currently located in a separate office but will eventually move to the newly developed facility.

As introduced in PART I of this chapter, the US subsidiary experienced significant changes in its knowledge base in the area of weighing products. Its original knowledge base was substituted by the knowledge sent from Germany that was integrated within the items of its product range. In other words, its main weighing products became redesigned by integrating technology that was developed in Germany. Moreover, the US subsidiary has experienced significant changes in its production function leading to a decrease in production costs over recent years in which it has operated under the MNC. In more detail, a lean approach towards production was successfully introduced. The US subsidiary has standardised more of its production processes, outsourced all activities that had nothing to do with its key business and selected better suited suppliers, who are to some extent, not only local suppliers but also global suppliers who also supply other subsidiaries of the MNC. In a nutshell, today the US subsidiary is able to achieve better quality products whilst having significantly decreased its production costs.

5.2.3 History and profile of the Indian subsidiary

Since the 1990s, the MNC has had a local production site in India, established by its biotech business. Initially, this Indian subsidiary represented a joint venture of an Indian firm and the MNC. Over the years, the Indian subsidiary has been continuously enlarged, and restructured, and developed, to now become one of the major production and R&D sites of the MNC's biotech business. Realising the importance of the Indian market for its mechatronics business, and in particular for the potential exploitation of its process weighing technology, the MNC also established some of its mechatronics functions on the ground of its Indian biotech subsidiary.

In 2005, both businesses were merged and have, ever since, constituted a 100 % subsidiary of the MNC. By the time the field research was carried out, the Indian subsidiary employed approximately 500 employees of whom around half are employed in the biotech business, with the other half being employed in the mechatronics business. In the latter half of 2009, most employees of the Indian subsidiary moved to a new facility. Until now, various different facilities of the Indian subsidiary exist that are scattered over a single industrial area in Bangalore. The new facility will provide enough space to integrate all of the different facilities in one place. Moreover, it will provide additional space for production, labs and further office space. This major investment is seen not only at headquarters' level, but also on the ground of the Indian subsidiary, as a sign of the relevance of India as a growth market and the value of the Indian subsidiary for maintaining the competitiveness of the overall MNC. Besides the presence in Bangalore, the Indian subsidiary also encompasses a variety of regional offices and service centres that are spread over several locations throughout India.

Sharing the technical knowledge of the headquarters as well as the other German subsidiaries with its own knowledge base, the Indian subsidiary constitutes a solution

provider of weighing equipment covering analytical weighing, and predominately, industrial weighing (process weighing solutions, loadcells, system engineering). It also possesses a key competence related to electronics and software engineering. From the headquarters´ perspective, the decision to establish one of its largest production and R&D sites in India was, primarily, made because the MNC wanted to be as geographically close as possible to the Indian customers to exploit its own technological expertise, the knowledge of an Indian R&D function and to take advantage of the Indian cost of labour structure. Moreover, tariff barriers are avoided by having a local presence in India.

5.2.4 Results and discussion of the sub case studies at subsidiary level

The following paragraphs present a detailed overview of the results and the discussion of the sub case studies carried out at subsidiary level. Because the research setting in respect of the subsidiary level encompasses three subsidiaries, the results are individually presented in reference to the respective subsidiary. The subsequent paragraphs further present the key theoretical insight which emerged from the field research. In this respect, it is one main aim of the subsequent paragraphs to demonstrate how the theoretical insight is grounded in the data. To provide for a more reader friendly structure, the research questions applied to the subsidiary level are organised in three sections.

THEORETICAL INSIGHT III

The senior local management of a subsidiary plays a key role in motivating its employees to create new knowledge bases and learning capabilities, and to discuss drivers of this motivation with the headquarters.

SECTION I

SECTION I combines the presentation and the discussion of the data collected as part of the questions of when and why a particular subsidiary regards the headquarters as interested in its specific knowledge base, as well as in what way a particular subsidiary perceives the headquarters as motivating it to create new knowledge bases and learning capabilities.

5.2.4.1 When and why does a particular subsidiary regard the headquarters as interested in its specific knowledge base?

5.2.4.1.1 Research question 1: results

- **The Philippine subsidiary**

The analysis of the data indicates that the employees, senior local managers as well as software engineers, regard the headquarters and other German subsidiaries as interested in the specific knowledge base of the Philippine subsidiary. Observations identified by all seven interviewees that reflect this interest by the headquarters, are primarily reflected under the heading of ´regular communication´, and this being conducted via the Internet e.g. email, chat, video conferences and telephone as well as a ´high level of general support´ that is offered by the headquarters as well as the other German subsidiaries. Moreover, to have the

opportunity to visit Germany for training is discovered as a further important concept across all seven interviews with the senior local managers and software engineers, being recognised as representing a subsidiary, which offers a valuable knowledge base for the overall MNC. This understanding of being a subsidiary with a valuable knowledge base had not always been in existence. The case study discovered that this understanding has slowly developed over the years and is still seen as a work in progress.

The comments made by the two interviewees who are senior managers led to the conclusion that the senior local management of the Philippine subsidiary is convinced that it had to prove that they constituted a valuable knowledge base, as well as loyal partners who the headquarters could increasingly turn to over recent years. Interviewee 10 pointed out in this context:

"I know that we as a subsidiary had to prove ourselves, as well as we had to demonstrate that we are a partner the headquarters can trust. That has not always been easy. However, our continuous growth in employees here in the office is a sign that we are on the right track."

The case study showed throughout the interviews that to the present time, that incidents occur where communication with the headquarters is difficult; for instance, when the employees on the Philippines have to deal with delayed responses from Germany that are, in some cases, understood as a sign of a lack of interest in the specific knowledge base of the Philippine subsidiary.

- **The US subsidiary**

The data generated from all interviewees that the employees understand their subsidiary as strategically important to the overall MNC, and therefore think that an interest of the headquarters in its specific knowledge base should exist. However, when this issue is discussed in more detail, it becomes obvious that there is a strong feeling, especially among the senior local management, that the headquarters does not recognise the importance of the

specific knowledge base of the US subsidiary at all. This applies, for instance, to the market knowledge that the US subsidiary holds. To give an example, interviewee 13 of the US subsidiary highlights that he feels that although he regularly communicates to the headquarters that the North American market, which is one of the main markets that the MNC covers, is substantially different to the markets that the MNC faces in Germany, Europe or Asia, the headquarters does not listen to his remarks. The differences between the North American market and the other markets are, to a large extent, manifested by specific product needs and the precise demands of the North American customers e.g. size and design of the products or units of measurement. From the perspective of senior local management in the US, these differences are not adequately taken into consideration by the headquarters. In detail, interviewee 13 reported:

> *"I feel that the headquarters does not understand why we have to make severe adaptations to our products in order to sell them successfully in the North American market. The headquarters always asks...why do you have to make these changes? Are they really necessary? Why are they necessary?"*

Interviewee 13 further identifies that these doubts of the headquarters, together with the discussions that are needed to convince the headquarters to give its blessing to product adaptations, would usually take up much valuable time. Within this lost time period during which no adaptations are made, the competitors often catch up with the products offered by the MNC and are able to take the business away from the MNC.

Moreover, the interpretation of the data indicates that the R&D function of the US subsidiary regards the headquarters as not being interested at all in its specific knowledge base. More concretely, in the interview with interviewee 17, it emerged that at headquarters' level there would be a tendency to overdesign, whilst the R&D function of the US subsidiary, takes a different approach that it feels is not acceptable to the headquarters.

- **The Indian subsidiary**

The case study looking across the different functions reveals that the headquarters is regarded as being interested in the specific knowledge base of the Indian subsidiary. Specific knowledge base areas of interest are seen in the R&D function. The data suggests that the interviewees are confident that the specific knowledge base of the Indian subsidiary constitutes a valuable part of the knowledge base of the overall MNC. In particular, it was discovered that a general understanding in the Indian subsidiary exists that without the knowledge base of the Indian subsidiary, the knowledge base of the overall MNC would be substantially less valuable and competitive in respect of other knowledge bases of similar MNCs in the market.

Taking an in-depth analytical approach in the factors that lead to this discovered confidence in its own knowledge base, and associated with this confidence was the interest of the headquarters' management in the Indian knowledge base, the following categories were identified:

The size of the Indian market and its current and potential future global relevance to the MNC are two related issues that reflect the confidence of interviewees to understand the knowledge base of their subsidiary as especially relevant to the headquarters. They report that only through a strong presence of the MNC in India, in regard to production as well as R&D, is it possible for the headquarters to serve the Indian market successfully.

The relatively low cost of labour in India, compared to the cost of labour in other parts of the world, and in particular in Germany, is a further concept representing the confidence of the interviewees and their perceived interest of the headquarters in the specific knowledge base of the Indian subsidiary. The data suggests that a clear understanding exists that in order

to stay competitive, particular production and R&D processes must be located in India to remain cost effective.

The quality of the employees in general, as well as the availability of Indian expert engineers, are two additionally important concepts representing the confidence found amongst the interviewees and the interest by the headquarters in their specific knowledge base. In particular, the case study identifies that the understanding exists amongst all interviewees that the developers of the R&D function are not only recruited from a large pool of potential expert candidates available in India, but also that they are especially qualified and motivated to create and share their knowledge with their colleagues.

To sum up the paragraphs above, the case study reveals that the three subsidiaries differ in respect of when and why they regard the headquarters as interested in their specific knowledge bases or not. While the Philippine and Indian subsidiaries generally regard the headquarters as interested in their specific knowledge bases, the US subsidiary regards the headquarters as lacking interest in its specific knowledge base. In particular, it was discovered that the senior local management of the US subsidiary suggests that if the MNC headquarters was more interested in the specific knowledge base of the US subsidiary, especially its market knowledge, the MNC would be more successful in the North American market.

5.2.4.1.2 Research question 1: discussion

Chapter two identifies that the literature does not precisely suggest when, or why, a particular subsidiary regards the headquarters as interested in its particular knowledge base. Based on the theoretical concept put forward by Gupta and Govindarajan (2000), that the value of a particular unit´s knowledge base to other units within a business network is characterised by two aspects, being that the knowledge base must be non-duplicative and the non-duplicative knowledge must constitute relevant knowledge to the other units within the business network,

the case study was partly approached by focusing on the exploration considering whether a particular subsidiary regards its specific knowledge base as non-duplicative, and at the same time relevant to either the headquarters, or to other subsidiaries and units within the whole business network. Moreover, one aim of the case study is to identify whether a particular subsidiary regards its specific knowledge base as non-duplicative, and at the same time, of relevance to either the headquarters, or to other subsidiaries and units, within the overall business network or not. This evaluation was suggested to become potentially linked to whether it also considers the headquarters as interested in its specific knowledge base or not.

One exciting aspect that the case study reveals, by adopting this approach, is that all studied subsidiaries regard their specific knowledge bases as non-duplicative, and at the same time of relevance to the overall business network. However, the case study also reveals that this evaluation of the specific knowledge bases does not necessarily suggest that a particular subsidiary regards the headquarters as interested in its specific knowledge base. The Philippine and Indian subsidiaries regard their specific knowledge bases as non-duplicative and of relevance to the overall business network and regard the headquarters as either generally (the Philippine subsidiary), or especially (the Indian subsidiary), interested in its specific knowledge base. In contrast, the US subsidiary regards its specific knowledge base as non-duplicative and at the same time of relevance to the overall business network, but does not regard the headquarters as interested in its specific knowledge base.

In summary, an exciting conclusion of the case study is that although a particular subsidiary regards its specific knowledge base as non-duplicative and at the same time of relevance to the overall business network, this does not necessarily suggest that it regards the headquarters as interested in its specific knowledge base.

In addition to this aspect that relates to the particular approach taken to operationalise this first research question, the case study reveals a variety of different concepts and categories that are linked to when and why a particular subsidiary is regarding the headquarters as interested in its specific knowledge base. For instance, in the Philippine subsidiary, the case study identifies that regular communication with the headquarters, as well as training at headquarters level, are important factors that lead to the Philippine subsidiary regarding the headquarters as interested in its specific knowledge base. Moreover, in the Indian subsidiary peculiarities of the Indian economy seem to dominantly influence the Indian subsidiary to feel confident about its own knowledge base and, linked to this confidence, to regard the headquarters as interested in its specific knowledge base.

5.2.4.2 In what way does a particular subsidiary perceive the headquarters as motivating it to create new knowledge bases and learning capabilities?

5.2.4.2.1 Research question 2: results

- **The Philippine subsidiary**

The analysis of the data collected as part of this research question is complex. The general understanding gained is that, although it is perceived that the headquarters and other German subsidiaries have a clear interest in their employees in the Philippines, and feel motivated to create, reverse and share knowledge with their German colleagues in jointly conducted projects, the headquarters and other German subsidiaries are not perceived as encouraging the employees thoroughly, predominantly the software engineers in the Philippine subsidiary, to create new knowledge bases or learning capabilities.

Interviewee 11 explains how and why this situation constitutes a form of problem for the Philippine subsidiary:

"Our software engineers are tied in mostly long-term projects in which they only use some of their qualifications… But as I pointed out, the software engineers have usually a number of qualifications that they want to develop further. Therefore, they also want to see training in these areas. Not to be trained is a dilemma for them and also encourages them to look for other employers".

This problem has been reported to the headquarters. However, the understanding of the senior local managers is that the headquarters continues to be concerned that their Filipino employees are motivated to do their best in the projects, by giving them training opportunities and support in Germany, and in the Philippines in the software engineering areas that are needed for the current projects, but not in areas that are unrelated to the current projects, but are of interest to the software engineers for individual knowledge development. The case study reveals that the senior local management feels that, the investment by the headquarters in the training of the software engineers, in areas outside the areas currently needed in their projects, may result in the software engineers feeling confident in their jobs and staying with the MNC. In this respect, interviewee 10 highlighted:

"I send them to training which is not necessarily related to the projects they are currently in but to other fields. We learned that it is really important to offer this training. It helps to keep the employees happy, and to keep them with the company."

In addition to the desire of the software engineers to acquire new knowledge bases and learning capabilities in the software engineering area, they are also interested in acquiring new knowledge in the areas of product engineering and learning German. The first subject mentioned here was explored and established that the software engineers feel that they are motivated by the headquarters to develop new knowledge bases and learning capabilities,

because they are given opportunities to visit the headquarters, or the other German subsidiaries, for up to three months, to acquire knowledge related to product engineering, whilst working face-to-face with their German-based colleagues. It seems to be especially important for the Filipino software engineers to have the opportunity to visit Germany and see the products in which their software is used. A phrase that has been used by the majority interviewees is reflected by the comment of one software engineer:

"I am interested in the complete product not only the software component which I develop with my team."

With regard to the desire of the Filipino software engineers to learn basic German, the training is not initiated by the headquarters but by the senior local management. The senior local management has learned that training, not just in software and product engineering, but also in areas completely unrelated to engineering, is important to tie their employees to the subsidiary.

Moreover, to provide employees with an opportunity to learn German is not simply a way of motivating their employees to perform well in their jobs, but also helps to deepen the social ties with their German colleagues. Throughout all interviews that were conducted what became evident was the importance of the most senior local manager, the president, to encourage training among the subsidiary's employees and to dicuss drivers of this motivation with the headquarters' managers. His ideas on training, especially in areas outside the engineering expertise needed for current projects, do not always correspond with those of senior managers of the headquarters; nevertheless, it was identified that he has generally found ways to convince his counterparts of the importance of this form of training, which is not, according to him, an easy task.

- **The US subsidiary**

The general understanding gained from the data is that the employees in the US subsidiary do not perceive the headquarters as motivating them to create new knowledge bases and learning capabilities. To give two examples that demonstrate the level of motivation within the US subsidiary:

Interviewee 13 pointed out:

"My impression is that the headquarters prefers us to be a good strong follower than a leader in regard to technology development...I think that the headquarters is not ready to have technology leadership outside the home country."

Having gained this understanding, the motivation to create new knowledge bases and learning capabilities is low.

Interviewee 17 points out that his motivation to create new knowledge bases and learning capabilities is generally low. The development of this low level of motivation can be traced back to the negative experiences that interviewee 17 made when communicating his knowledge to his colleagues at headquarters´ level:

"It isn´t easy to communicate my ideas to my colleagues in Germany. I don´t get their attention."

The little feedback he received discouraged him; he felt that his German colleagues rejected the way he had developed a part of a device, and theirs was an inappropriate approach. Moreover, he reported that the headquarters did not motivate him to create new knowledge and learning capabilities because there was no facilitation to participate in online courses, offered by external providers, in his specific area of engineering. To participate in these online courses, separate Internet connection is needed that allows him access to the training sites. The Internet connection proposed by the headquarters does not grant access,

thus the developer feels that the headquarters is not interested in him gaining access to the Internet and thereby to access new knowledge and learning capabilities.

Although the case study identifies that the interviewees in the US subsidiary do not perceive the headquarters as motivating them to create new knowledge bases and learning capabilities, the interviewees still feel motivated to create new knowledge and learning capabilities. What emerges from the data is that this motivation is initiated by the senior local management of the US subsidiary. In this respect, the data develops the concept that the interviewees clearly differentiate between the headquarters' management and the senior local management of the US subsidiary, and acknowledge that there are attempts to provide, for instance, additional training by the senior local management of the US subsidiary, but that in general it appears to be difficult to stand up to the headquarters who are seen as lacking interest to provide for any additional training.

- **The Indian subsidiary**

The case study suggests that this research question is mainly relevant for the R&D function. Interviewees from other functions, although they report that they perceive the headquarters as being interested in the development of their positions, they do not regard the headquarters as taking an active role in motivating them to create new knowledge and learning capabilities.

In regard to the R&D function, there is no single concrete answer to the question in what specific way employees feel motivated by the headquarters to create new knowledge bases and learning capabilities or not. On the one hand, motivation exists in this respect, this motivation is attributed to the rise in numbers of R&D employees over recent years. The R&D function began with only three employees.

Interviewee 27 emphaised:

"We have expanded our activities over the last years. Today we already have 18 employees in this unit.

And there will be more employees working here in the future - that´s for sure."

These 18 R&D employees cover the areas of mechanical engineering, electronics and software engineering. Another concept of motivation is attributed to the nature of the R&D work. Whilst at the beginning, the R&D function was concerned with the development of minor adaptations of existing products to make them fit the specific requirements of the Indian customers, the R&D function is currently involved in more sophisticated technical developments involving numerous projects, with regard to products that are developed for India and the global market. On the other hand, the employees in the Indian R&D function do not perceive the headquarters as motivating them to create new knowledge and learning capabilities. The data indicates that the notion exists amongst the interviewees that the headquarters does not effectively exploit the R&D function in India. In the opinion of the interviewees, the R&D function could play a much more important role for the overall MNC, if the headquarters would allow it to take over more projects and to engage in more technical developments of products, not only relevant to the Indian market, but for the global market too. Because of this, the R&D function does not perceive the headquarters as motivating it to create new knowledge bases and learning capabilities. Interviewee 27 claims in this respect:

"If you compare the numbers of software engineers with the ones when we started out, you can really see the difference. This department is growing and growing. Our work is getting more important. I think that the headquarters management has not realised the full potential of our skills and knowledge yet."

In line with the results revealed in respect of the Philippine and the US subsidiaries, what emerges from the data is that the senior local management is regarded across all nine

interviews as important to motivate the Indian employees to create new knowledge and learning capabilities and also to negotiate additional training with the headquarters management.

In conclusion, the case study indicates that the three subsidiaries differ in the way they perceive the headquarters as motivating them to create new knowledge bases and learning capabilities. While the case study identifies different concepts of the way the Philippine and Indian subsidiaries perceive the headquarters as motivating them to create new knowledge bases and learning capabilities, the case study also reveals that the employees in the US subsidiary do not perceive the headquarters as motivating them to create new knowledge bases and learning capabilities at all. What is noteworthy is, that within all three subsidiaries, there is motivation to create new knowledge and learning capabilities. This motivation is reported to be initiated by the senior local management.

5.2.4.2.2 Research question 2: discussion

The results identified above present two aspects in particular that must be discussed in more detail. The importance of rewards as a way to lead employees in the subsidiaries to perceive the headquarters as motivating them to create new knowledge bases and learning capabilities, and the role of the senior local management on the ground of the subsidiaries to motivate their employees to create new knowledge and learning capabilities, and communicate drivers of this motivation to the headquarters, are discussed.

The importance of rewards to motivate the creation of new knowledge and learning capabilities

In the broader sense, chapter two presents that the literature identifies that rewards and incentives that can take various different forms e.g. money and social rewards are important drivers for encouraging effective knowledge management (Argote et al., 2003; Yahla and

Goh, 2002). In reference to this broad theoretical concept, the case study reveals much more nuanced insights from the field. To give some examples, the case study carried out in the Philippine subsidiary reveals that additional training (in the area of product engineering) is regarded as the main driver why the Philippine subsidiary perceives the headquarters as motivating it to create new knowledge and learning capabilities. Additional training raises costs for the MNC, but at the same time constitutes a reward, and an expansion of individual knowledge to the software engineers on the ground of the Philippine subsidiary.

In reference to the US subsidiary, the absence of rewards is examined as causing employees to perceive the reluctance of the headquarters to motivate them to create new knowledge and learning capabilities. This conclusion is drawn from the result that the interviewees feel that the headquarters demonstrates towards the subsidiary, that on the one side the technologies that are created at headquarters level are more advanced in comparison to those found on the ground of the US subsidiary, and on the other side the headquarters does not show much interest in the market knowledge that the US subsidiary creates and reverses to the headquarters. In line with the Philippine subsidiary, training was identified to be an important driver for motivating the employees in the US subsidiary to create new knowledge and learning capabilities, but as is present in the Philippine subsidiary, the lack of providing sufficient training leads to a lack of motivation. However, the form of training required in the US subsidiary is different from the one in the Philippine subsidiary because the training explicitly relates to the projects that are carried out within the subsidiary, and not as in reference to the Philippine subsidiary, to areas outside the projects.

In respect of the Indian subsidiary, it identifies that there is a relationship between rewards and the way the Indian interviewees perceive the headquarters as motivating them to create new knowledge and learning capabilities. Here, the central reward deals with the

opportunity given to the developers within the R&D function to become involved with more sophisticated R&D. On the one side, to deal with more sophisticated R&D means that the developers increasingly exploit and enlarge their individual knowledge, on the other side, to deal with more sophisticated R&D is also regarded by the interviewees as a sign that the headquarters attaches increasing value to the knowledge that is created on the ground of the Indian subsidiary.

The importance of the subsidiary's senior local management to motivate the creation of new knowledge bases

The case study discovered that in all three subsidiaries, the senior local management is identified, by all interviewees, as being especially responsible for motivating its respective employees to create new knowledge bases and learning capabilities, and to discuss drivers of motivation with the headquarters.

In the US subsidiary, a feeling exists of not being motivated at all by the headquarters management to create new knowledge bases and learning capabilities, this feeling does not relate to the senior local management of the US subsidiary, who are seen as motivating the employees to create new knowledge and learning capabilities, and are also reported to have difficulties in standing up to the headquarters that is seen as not being interested in providing, for instance, additional training.

Similarly to the US subsidiary, the field research in the Philippine and Indian subsidiaries highlights the importance of the senior local management of each subsidiary to motivate its employees to create new knowledge and learning capabilities. Especially in respect of the Philippine subsidiary, it was also discovered that the attempts of the senior local management to provide for additional training for its software engineers constitutes a fight that they engage in constantly with the headquarters.

Grounded in the results identified above, the case study reveals the following valuable theoretical insight: the senior local management of a subsidiary plays a key role in motivating its employees to create new knowledge bases and learning capabilities, and to discuss drivers of this motivation with the headquarters.

To sum up, SECTION I presented the way in which the field research discovered different concepts that can be linked to the questions of when and why a particular subsidiary regards the headquarters as interested in its specific knowledge base. Moreover, the analysis of the data which was collected in reference to the research question that explored in what way a particular subsidiary perceives the headquarters as motivating it to create new knowledge bases and learning capabilities suggested that rewards are important in order that a particular subsidiary regards the headquarters as interested in its knowledge base. SECTION I further demonstrated how the theoretical insight emerged from the data which was collected in reference to the second research question applied to the subsidiary level.

SECTION II

SECTION II combines the presentation and the discussion of the data collected as part of the questions of how and why a particular subsidiary faces obstacles when sharing knowledge with the headquarters, as well as in what way a particular subsidiary is willing to reverse its key knowledge to the headquarters and faces risks when reversing this key knowledge to the headquarters.

5.2.4.3 How and why does a particular subsidiary face obstacles when sharing knowledge with the headquarters?

5.2.4.3.1 Research question 3: results

- **The Philippine subsidiary**

The data suggests that the Philippine subsidiary faces minor obstacles when sharing knowledge with the headquarters and other German subsidiaries. One obstacle that both senior local managers and software engineers report is the time difference (of seven hours) between the Philippines and Germany. Representing three of his colleagues, one software engineer pointed out:

> *"Well, I would say that in some projects I face problems when I want to share what I know. It is sometimes difficult to share knowledge because of the time difference… However, I feel that on a general basis there are not so many obstacles that I face when I want to share knowledge. Everyone in Germany is quite approachable, the atmosphere is good."*

To overcome the obstacle related to the time difference, the employees in the Philippines stay longer in their offices in the afternoons or at times when communication is intense and projects must be finalised. They are compensated by arriving later at the office the

following day. Nevertheless, the time difference poses an obstacle to the effective sharing of knowledge and has caused delays in projects in the past.

The circumstance that the common language of communication is English also causes an obstacle. All interviewees have mentioned that they regularly experience a feeling of some important knowledge being "lost in translation", leaving them with the feeling of being misunderstood, or not being able to clearly understand what their German colleagues mean by what they say. To overcome this obstacle, having regular video conferences (two to three times a week) have proved to be a good idea. For one project, there is even a daily video conference that is perceived as especially helpful to quickly share knowledge and to minimise misunderstandings of both parties and to have a clear direction to follow. This video conference normally takes place at 5 p.m. Philippine time and lasts between 10-15 minutes; if required, the video conferences may also be extended to 30 minutes or up to an hour. In some projects however, the communication is heavily dependent on emails, these are seen as problematic for the Philippine software engineers. They would like to see daily video conferences in almost all projects; however, they feel that the decision how often, and when, a particular video conference takes place, exclusively depends on the German manager responsible for that particular project. In the past for instance, communication problems meant that, a software engineer worked for two weeks on one particular task before learning that a misunderstanding with the headquarters and the other German subsidiaries had occurred resulting in two lost weeks of work and the project had to start again from scratch.

- **The US subsidiary**

Obstacles in respect of the sharing of knowledge with the headquarters have been identified to mainly existing amongst the senior local management of the US subsidiary and its R&D function. As mentioned in earlier paragraphs, the senior local management reported a

feeling of not being understood at headquarters level; a reality that it attributes to a lack of willingness of the headquarters to exploit and share knowledge. This relates especially to the context of the market knowledge in respect of the differences between the North American market and customers, in contrast to the other markets and customers that the MNC serves. In particular, the data indicates that what results from the perception of not being understood at headquarters level, is a general feeling of remoteness and outside the decision making process of how to tackle a particular market while at the same time being held responsible for sales revenues that continuously increase. The case study led to the conclusion that this feeling has clearly led to frustration. In respect of the R&D function, the dominant obstacles faced in the process of knowledge sharing were already mentioned; however, there is one further obstacle that must be mentioned: interviewee 13 reported:

"What happens quite often is that within six months after my developers return from Germany, they leave the company."

In this connection, the researcher posed the question of why the developers decide to leave. Interviewee 13 responded that very different approaches toward product development between the US and Germany could be considered as one reason that explains this situation.

- **The Indian subsidiary**

The case study identifies that, in the view of all interviewees, only minor obstacles exist when sharing knowledge with the headquarters. These minor obstacles are associated with the time difference (of five hours) between India and Germany, and to translation errors. However, the R&D and sales functions especially reported that, on a general basis, besides minor translation errors, they face a conducive atmosphere within the MNC that allows for easy communication e.g. through emails and internal web portals between the headquarters and the Indian subsidiary, as well as among the different subsidiaries of the overall business network.

In conclusion, all three subsidiaries face obstacles when sharing knowledge with the headquarters. While the case studies carried out within the Philippine and the Indian subsidiaries suggest that the obstacles are mainly linked to differences in time, language or communication; the obstacles faced by the employees within the US subsidiary seem to be more profound. Especially within the R&D function, it seems to be difficult to arrange for effective knowledge sharing between the US subsidiary and the headquarters, which has led to many developers leaving the subsidiary in the past.

5.2.4.3.2 Research question 3: discussion

Based on the case study in respect of this third research question, there are two aspects that must be discussed in more detail. In this respect, the following paragraphs discuss how the subsidiaries differ in the obstacles that they face when sharing knowledge with the headquarters. Moreover, the way in which context similarity can prevent obstacles that subsidiaries face when sharing knowledge with the headquarters is explored in more detail.

Differences of the obstacles that subsidiaries face when sharing knowledge with the headquarters

A key aspect of the conducted case study is that the three case subsidiaries differ in respect of the obstacles that they face when sharing knowledge with the headquarters. While the Philippine and the Indian subsidiaries primarily identify differences in time, language or communication as obstacles in the process of knowledge sharing with the headquarters, the US subsidiary reveals that its main obstacle is that the headquarters is not willing to exploit and share the knowledge that the US subsidiary intends to share. Here, the main types of knowledge discussed were market knowledge and knowledge related to R&D that the US subsidiary intends to share. Taking a more abstract perspective, the field research reflects that the Philippine and the Indian subsidiaries do not regard the partner, the headquarters, with

whom the subsidiary wants to share knowledge as the obstacle to the knowledge sharing process, but to particularities e.g. differences in language, which are aspects not directly linked to the relationship between headquarters and subsidiary, as causing obstacles within the knowledge sharing process. While the US subsidiary clearly points to the headquarters as not willing to exploit and share the knowledge that the US subsidiary wants to share. In this context, time, language or communication differences among the US subsidiary and headquarters are not regarded as the obstacle. The field research was also intented to focus on potential reasons why subsidiaries face obstacles when they share knowledge with the headquarters. However, the analysis of the data could not lead to valuable input in respect to this question. Here, future reseach is needed. Research in this area is seen as valuable, because taking a closer look at why particular obstacles occur in the knowledge sharing process in the headquarters-subsidiary context exist might provide insights as to how to overcome these obstacles in order to optimise knowledge sharing within the MNC.

Context similarity prevents obstacles in the knowledge sharing process

The literature on knowledge sharing highlights the importance of context similarity in the process of knowledge sharing (Ahn et al., 2005). In detail, Inkpen and Dinur (1998), put forward that knowledge sharing amongst different units in the MNCs is effective, if a context similarity exists between the sender and the recipient in the following five dimensions: a strategic dimension, a decision-making dimension, an environmental dimension, a cultural dimension and a technological dimension. Although, the key focus of this third research question relates specifically to obstacles that the subsidiaries face in the knowledge sharing process, the case study focuses on the headquarters-subsidiary context, the data nevertheless suggests that context similarity is essential in order to prevent obstacles in the knowledge sharing process. The case study identifies that in all three subsidiaries, knowledge sharing

with special regard to R&D related knowledge, can only process without obstacles if the knowledge that the subsidiaries reverse, and the knowledge that the headquarters possesses, and which is intended to be shared, must have a context similarity in their technological dimension. If this context similarity does not exist, the case study identifies, in reference to the Philippine subsidiary, that there have been instances in the past when knowledge that was created at the Philippine subsidiary could not be shared effectively with the headquarters because there was no context similarity with the knowledge available at headquarters level, this was due to misunderstandings in previous communications about the characteristics of the knowledge that should have been created at subsidiary level, therefore in such a scenario, knowledge cannot be shared effectively. Context similarity, or better the lack of context similarity, also explains the obstacles of the US subsidiary when sharing knowledge with the headquarters in respect of market knowledge that the US subsidiary has and shares. Here, context similarity is understood in its strategic and decision making dimension. Because there is a lack in the strategic and decision-making context similarity of the shared knowledge between the US subsidiary and the headquarters, knowledge is not shared without obstacles amongst the parties. This analysis of the subsidiary data also reflects what has been found at headquarters´ level. Here, the case study identified that the headquarters´ management is aware of the lack of a strategic and decision-making context similarity with the US subsidiary.

In conclusion, two key aspects that emerge from the case study are that, first of all, subsidiaries differ in the obstacles that they face when sharing knowledge with the headquarters. Due to the lack of data in terms of why obstacles exist, further research is needed. Secondly, the case study reveals the importance of context similarity of the knowledge that is intended to be shared in the headquarters-subsidiary context. Context similarity was examined as potentially preventing obstacles within the knowledge sharing process.

5.2.4.4 In what way is a particular subsidiary willing to reverse its key knowledge to the headquarters?

5.2.4.4.1 Research question 4: results

- **The Philippine subsidiary**

The field research identifies that all interviewees claim that they are willing to reverse their key knowledge to the headquarters and other German subsidiaries. What emgerged from the different data sources is reflected in the following citation of one software engineer:

> *"I think it is quite normal to share what you know. Is this not one reason why one joins a company. If I was not willing to share what I know, I think I could not work in a corporate environment."*

Further data underlines the concept, that the software engineers are not only willing to reverse their key knowledge because they consider it to be their job but also because they see the process of knowledge sharing as an opportunity to show that they qualify for being invited to take part in future projects.

In a more abstract perspective, they regard themselves as being a service provider and do not fear making their key knowledge available to the headquarters or the other German subsidiaries. What the case study also reveals is that in all interviews, this research question was perceived as rather unnecessary by the interviewees. This behaviour is demonstrated because the employees in the Philippine subsidiary do not perceive their knowledge as a source of bargaining power with the headquarters. It seems that their understanding of the importance of their knowledge base is that it is valuable to the overall business network. For them, it is important to demonstrate that they are part of the MNC and the overall MNC knowledge base respectively.

- **The US subsidiary**

Similar to the outcome of the field research in the Philippine subsidiary, the overall understanding gained from the field research is an existence of willingness to reverse key knowledge to the headquarters. However, what differs between the two subsidiaries is that within the Philippine subsidiary, this willingness is closely related to the motivation to reverse key knowledge, and to be part of the overall MNC knowledge base. The willingness of the US subsidiary cannot be related to any motivation to reverse its key knowledge to the headquarters. This lack of motivation is caused by the negative experiences that have taken place while sharing knowledge with the headquarters in the past.

- **The Indian subsidiary**

The field research indicates that all interviews show that a willingness exists to reverse all key knowledge to the headquarters. In this connection interviewee 21 pointed out:

"It is one of the most important issues here; we have to combine
our knowledge to be successful. Everyone has to contribute.
This is just the way it always is and should be."

Moreover, the case study identifies that all those interviewed do not even ask themselves the question whether they are willing to reverse their key knowledge or not. For them, it seems to be the common practice to reverse and to share whatever they know. This practice can be found across all functions that were studied. However, across all functions except the sales and R&D functions, the data suggests that although the willingness to reverse key knowledge exists, there is also an awareness that most of the key knowledge is relevant for operating the Indian subsidiary only, thus even in the cases in which it is reversed to the headquarters, it will hardly be shared or exploited at headquarters' level. To give an example, in the human resource function, distinct key knowledge exists dealing with recruitment strategies for gaining access to experts in the field, or about distinct employment laws and regulations, which are specific to the Indian context and which must be known for running the

Indian subsidiary successfully, and which are also worth sharing with the MNC headquarters. Nevertheless, this key knowledge is specific to the Indian subsidiary and, most likely, cannot be exploited by the headquarters in Germany. Interviewee 23 stated in this respect:

"I mean it is quite obvious I guess, there are many differences between India and Germany in respect of labour and employment in general."

As a further example, a similar case to the human resource function can be found in the production function. Because of the relatively low cost of labour in India, the production processes do not involve a large extent of automation. In other words, most production steps are labour intensive in India but not in Germany. For this reason, knowledge that is created within production, although the willingness of the employees to reverse their key knowledge exists, this knowledge is not reversed because it cannot be exploited in production processes elsewhere that are not as labour intensive and rely primarily on automation. The situation is different within the R&D function. Here, knowledge that is created at the Indian subsidiary can be exploited by the headquarters. The same is found within the sales function. The field research led to the conclusion that in both functions, an unrestricted willingness exists to allow the headquarters to gain access to the key knowledge base through reversing and sharing this key knowledge.

To sum up, the field research reveals that in all three cases, the willingness to reverse key knowledge to the headquarters exists. Especially in respect of the Philippine and the Indian subsidiaries, the question of their willingness to reverse key knowledge to the headquarters was regarded as unnecessary, as the employees of the various subsidiaries will not ask themselves the question. For them, it is common practice to reverse what they know.

5.2.4.4.2 Research question 4: discussion

The following paragraphs discuss two important aspects that the data reveals. First of all, the unrestricted willingness to reverse key knowledge to the headquarters in the context of the Philippine and Indian subsidiaries is discussed in detail. Secondly, by referring to the field research carried out at the US subsidiary, the negative experiences, when sharing knowledge are discussed, and how these impact on the motivation to reverse key knowledge to the headquarters.

The unrestricted willingness to reverse its key knowledge to the headquarters: the example of the Philippine and Indian subsidiaries

One key aspect of the field research carried out in respect of this fourth research question is that all three subsidiaries are willing to reverse their key knowledge to the headquarters. The following paragraphs identify that in the case of the Philippine and the Indian subsidiaries, an unrestricted willingness exists to reverse key knowledge to the headquarters.[3] This aspect can be especially relevant for practitioners. Concretely, it demonstrates that in subsidiaries, located in emerging economies like the Philippines or India, who create valuable knowledge relevant to the headquarters, the obstacle of a lack of willingness by the subsidiaries to reverse and share their key knowledge with the headquarters, which might hinder the knowledge sharing process, does not occur. PART I of this chapter discusses that the headquarters faces a lack of willingness in its R&D function, located at headquarters level, to internally share its key knowledge. Keeping this aspect from the case study at headquarters' level in mind, the reality of an unrestricted willingness exists at subsidiary level in the Philippines, and in India, to reverse and share key knowledge, constitutes a reality that the headquarters' management

[3] One note on the experiences that were made when exploring this research question at subsidiary level in the Philippines and in India: when asking the questions, most interviewees made it clear that they do not understand why these questions are raised. They reported to regard their key knowledge as a basis for a successful collaboration with the headquarters and the overall MNC.

could take into consideration when organising future R&D activities in the context of the overall MNC.

The effect of negative experiences of knowledge sharing on the motivation to reverse key knowledge to the headquarters: the example of the US subsidiary

A further relevant aspect that the field research reveals in respect of this fourth research question is that although a willingness exists in the US subsidiary to reverse its key knowledge to the headquarters, the US subsidiary does not feel motivated to reverse its key knowledge due to the negative experiences that it had when sharing knowledge with the headquarters in the past. Initially it was not the aim of the case study to explore the extent to which a particular subsidiary regards itself as motivated to reverse its key knowledge to the headquarters.

However, this aspect constitutes a relevant insight for the headquarters' management. The reality that the US subsidiary does not regard itself as motivated to reverse its key knowledge to the headquarters constitutes a sign that the overall knowledge sharing process between the headquarters and the US subsidiary is not effective and therefore requires additional management efforts.

In conclusion, two important aspects that emerge from the field research are, that first of all, based on the sub case studies carried out in the Philippine and Indian subsidiaries an unrestricted willingness, to reverse key knowledge to the headquarters, exists; secondly, based on the sub case study conducted in the US subsidiary, negative experiences in respect of knowledge sharing in the headquarters-subsidiary context have an effect on the motivation of the subsidiary to reverse key knowledge to the headquarters.

5.2.4.5 In what way does a particular subsidiary face risks when it reverses its key knowledge to the headquarters?

5.2.4.5.1 Research question 5: results

- **The Philippine subsidiary**

The answer to this question is complex. Risks are seen as existing in cases where the knowledge that is created is lost in translation. It was pointed out that this loss of knowledge is mostly related to the fact that it could not be fully documented. Once again, all interviews reveal that the employees do not see their key knowledge as a tool for bargaining with the headquarters to progress their own agendas. In this respect, one of the software engineers highlighted:

"We know that we have to share our knowledge to push on our project. It doesn´t make sense to me to protect my own knowledge in a way that the headquarters is damaged. There is really no reason to keep knowledge only to myself."

Moreover, within the interviews none of the interviewees ever mentioned, or demonstrated, that he / she feels pride in what he / she knows or is able to do at the Philippine subsidiary. They are willing to share their knowledge with the knowledge at the headquarters' level and the other German subsidiaries, and do not fear that through knowledge sharing they may lose their key knowledge; it is their understanding that when they share their knowledge, the overall MNC will profit, which also implies that they will profit from it in some way. What emerges from this data is that the interviewees on the Philippines do not think as "we" here on the Philippines and "they" over in Germany; they think as "we all" no matter where they are geographically located.

- **The US subsidiary**

The field research indicates that all the interviewees from the US subsidiary do not feel that they face risks when reversing their key knowledge to the headquarters. This finding applies to all functions that were explored. Again, in line with the former questions asked within the interviews, the data demonstrates that there is no risk of reversing key knowledge to the headquarters, because the headquarters is regarded as not sufficiently interested in the knowledge reversed from the US subsidiary anyway. This is manifested, for instance in the following citation by interviewee 15:

"No, I guess what I know isn´t really important to HR in Germany.

There is no need to share what I know."

- **The Indian subsidiary**

The field research led to the conclusion that there is a clear understanding among all interviewees that they are facing no risks when reversing their key knowledge to the headquarters. This is, for instance, reflected in the following quote of interviewee 28:

"No, I don´t face risks when I reverse my knowledge to the headquarters.

I guess that within our company we are encouraged to share our knowledge while at the same time everyone is also responsible for his or her own projects."

Again, as explored under the latter research question, the field research identifies, in most functions, such as human resource or production, that although key knowledge exists, this knowledge is strongly linked to the particular context of the Indian subsidiary. Although this key knowledge is made available to the headquarters, it is not exploited elsewhere within the business network. Accordingly, within these functions, there is no risk to reverse key knowledge. Within the R&D and sales functions, there is a much stronger relationship with the headquarters and the other subsidiaries to reverse and share key knowledge. To sum up, the data indicates that within all functions including R&D and sales, there is an understanding

that to reverse key knowledge to the headquarters does not involve risks for the Indian subsidiary as the sender of knowledge.

In conclusion, the employees of all three subsidiaries generally feel that they do not face any risk when they reverse their key knowledge to the headquarters. However, the field research carried out in the Philippine subsidiary discovered that a risk when reversing knowledge to the headquarters exists when knowledge cannot be fully documented.

5.2.4.5.2 Research question 5: discussion

The key aspect that the field research identifies in respect of this fifth research question is that all subsidiaries do not feel that they are facing risks when they reverse their key knowledge to the headquarters. This constitutes an exciting aspect which has to be put in conjunction with one particular key aspect that the field research at headquarters' level reveals: at headquarters' level, it was identified that the headquarters' management faces the risk of knowledge loss when sharing knowledge with its business network of subsidiaries. Knowledge sharing was identified as a process that always includes the sender releasing some form of knowledge to the recipient. The risk is the potential knowledge loss that occurs when the headquarters shares knowledge with its subsidiaries.

To sum up, SECTION II presented that the field research discovered various aspects of how subsidiaries differ in the obstacles that they face when sharing their knowledge with the headquarters. The analysis led to the conclusion that context similarity of the knowledge which is supposed to be shared amongst the parties may play an important role in preventing obstacles related to the process of sharing knowledge. Moreover, SECTION II explored the willingness of the subsidiaries to reverse their key knowledge. It was further discussed that subsidiaries face no or only minor risks when reversing their key knowledge to the

headquarters. This finding was compared to one key result which emerged from the field research at headquarters level. In PART I, it was identified that the headquarters regards itself as facing risks when sharing its knowledge within its business network of subsidiaries.

SECTION III

SECTION III combines the presentation and discussion of the field research which explored the external environments of the various subsidiaries. In particular, it is identified who or what belongs to the different external environments. Moreover, the following paragraphs identify how the access to specific external environments influences the way knowledge is created within the various subsisdiaries. Finally, it is summarised why the employees regard their subsidiaries as offering valuable knowledge bases to the headquarters.

5.2.4.6 Who or what belongs to the external environment of a particular subsidiary?

5.2.4.6.1 Research question 6: results

- **The Philippine subsidiary**

The answer depends on whether the question is being asked to the senior local management or the software engineers. Important external partners for the senior local management are customers. These customers mostly come from the food and beverage or chemicals sector. Although the Philippines have not been a significant sales revenue market for the MNC up to the time when the field research was carried out, the senior local management highlight that this situation is likely to change in the future. In this context the interviewee 10 of the Philippine subsidiary highlighted:

"Our contact to customers is increasingly important to us. We want to understand their expectations. Only when we understand their expectations, we can offer suitable products in the Philippines in the future."

In other words, to learn about customer expectations constitutes an important form of knowledge sharing with external partners. The senior local management emphasise that their collaboration with both existing, as well as potential, customers is planned to be increased in the near future.

The five software engineers who were interviewed explain that their external partners are generally either friends from university, former colleagues, colleagues from other firms who they get to know when attending training courses and workshops organised by academic institutions, and people they get to know when using online community portals.

Knowledge sharing with external partners was identified as representing a common activity between software engineers. None of the interviewees mentioned that through this knowledge sharing a loss of their own knowledge could develop. When asked directly about the potential loss of knowledge, the responses were usually short, exemplified by a single sentence from one of the software engineers:

"No, there is no loss of knowledge".

Nonetheless, a concept that emerged from the field research was that the sharing of knowledge with external partners is very important to the software engineers. All of the five interviewees mentioned during the interviews that their work can be a lonely experience, and that they would even hazard the consequences of some loss of knowledge rather than not interact with their external partners.

- **The US subsidiary**

The most important external partners of the US subsidiary are its customers. These customers are based primarily in North America and have distinct expectations of the

products that they want to have. They are not willing to buy products that are designed in the German way and, although they are technically excellent, do not match their expectations in terms of size or other distinct criteria.

Moreover, the supply chain function highlighted the importance of suppliers as important external partners. This supplier base has become more global since the acquisition by the MNC. In this respect, interviwee 18 pointed out:

"A lot of our suppliers are part of the companys´ global supplier network....I think that due to the access to our new supplier network, we can offer better quality, and we are also more cost effective."

- **The Indian subsidiary**

The most important external partners of the Indian subsidiary are the customers within the Indian market. The sales function that encompasses several employees who had been working for the MNC even before there had been R&D and production functions in India, have especially strong, long-term relationships with their particular customer base. In this connection interviewee 22 cited:

"*For some time, we have regional sales offices across India. Many relationships with customers exist for many years. This is very useful and helps to develop our customer base in the future."*

Moreover, the sales function shares knowledge about these customers with other employees of the sales functions not only in India, but also within the overall business network of the MNC. Through the documentation of customer contacts and activities, potential new customers that are linked to the customers in India are also located in other markets outside India. Other important external partners of the Indian subsidiary are Indian-based suppliers. They are identified by the local supply chain function and constantly

monitored in terms of the quality of their products or product parts. To ensure the quality of the products that are developed and produced within the Indian subsidiary, the supply chain function follows strict standards when monitoring their suppliers. In cases where suppliers are not able to maintain the quality of their products, they are excluded from the supplier base and are not consulted a second time.

In conclusion, while the interviewees in the US and Indian subsidiaries highlight the importance of customers and suppliers as their main external partners, the employees in the Philippine subsidiary mainly rely on personal contacts as the most important external partners. This is not surprising, because the Philippine subsidiary is, primarily, concerned with software engineering and does not have any other substantial functions like the US and Indian subsidiaries.

5.2.4.6.2 Research question 6: discussion

In the following paragraph, two aspects of the results revealed in respect of this sixth research question are discussed. To begin with, the differences of the external environments that the subsidiaries develop are explored in more detail. Subsequently, on the basis of the results of the field research carried out in the Philippine subsidiary, it discusses the way in which the external environment constitutes a medium for potential knowledge loss.

Differences in the external environments of the subsidiaries: the example of the US and Indian subsidiaries

A key aspect of the field research carried out in respect of this sixth research question is that the three subsidiaries differ in the external environments that they develop. This aspect reflects the literature on the external environment as reviewed in chapter two. Nonetheless,

the US and Indian subsidiaries, although different in nature, both have their principal external partners as customers as well as suppliers.

The external environment as a medium for potential knowledge loss: the example of the Philippine subsidiary

A further valuable aspect that the case study reveals is that the external environment of the Philippine subsidiary constitutes a medium for potential knowledge loss. The field research highlights that the software engineers depend on close ties with their external partners, in order to discuss particular problems that they face when completing the tasks set by the headquarters. These discussions always include some knowledge loss, because the knowledge is shared with an outsider.

5.2.4.7 How does the access to a specific external environment influence the way knowledge is created within a particular subsidiary as well as reversed by a particular subsidiary to the headquarters?

5.2.4.7.1 Research question 7: results

- **The Philippine subsidiary**

Although the market in the Philippines is to be developed much more in the future, the two senior local managers who were interviewed are convinced that the knowledge that they currently share with their customers in the Philippines, influences the knowledge that they reverse to the headquarters. For the future, when more collaboration with customers is planned, the extent to which knowledge is shared with the customers and reversed to the headquarters' management is to be extended.

All software engineers who were interviewed point out that their specific external partners have a significant influence on how knowledge is created at the Philippine

subsidiary. Because of their support, it is almost always possible to solve particular problems and thus the external partners have an indirect influence on the knowledge that is later reversed to the headquarters.

- **The US subsidiary**

The senior local management stress the importance of the North American customers as their most significant external partners who influence the local knowledge creation process as well as the ability to reverse knowledge to the headquarters. A short while before the field research was conducted, the close collaboration with one of its customers from the pharmaceutical sector led to a shared adaptation of an existing weighing product to the specific needs of a customer. Interviewee 13 highlighted in this respect:

"On our tour, I also mentioned the name of one of our key costumers. Together we developed a specific weighing instrument which has no display and is used for testing consumer behaviours."

Because this adapted product could also, potentially, be of relevance to other customers from this or a related sector, the collaboration with the customer has been especially beneficial to the US subsidiary. In other words, this collaboration not only enabled knowledge creation but also created knowledge that could be reversed to the headquarters.

- **The Indian subsidiary**

Through the close relationship with Indian customers, their expectations and their expertise, new products are generated. Therefore, the access to Indian customers has a significant impact on the way knowledge is created at the Indian subsidiary. In these cases where products that have been developed in India, and which are expected to also be of interest to customers outside India are sold globally, the knowledge that is gained through the access to the Indian customers also influences the knowledge that is reversed to the headquarters.

Taking a closer look at the influence of the access and the availability of the external partners on the way knowledge is created at the Indian subsidiary, as well as the ability of the Indian subsidiary to reverse knowledge to the headquarters, the case study reveals that the extent of knowledge sharing with external partners, the creation of new knowledge and the extent of how new knowledge can become reversed to the headquarters, has been continuously increasing over the years. The development of new products that meet the expectations of the Indian customers was also, in the beginning, also heavily dependent on the support of the headquarters. However, the dependence on the headquarters to create new knowledge has been reported to be far less by the time the field research was carried out. In many cases, it seems that the R&D function feels that it could develop much more if the headquarters would give them the opportunity.

Moreover, knowledge sharing with customers has also led to a much higher speed of how products are developed as well as produced. For instance, one customer required a weighing product to determine the weight and volume of suitcases and bags of passengers boarding aeroplanes. The customer wanted to have the scales available within 30 days. The

R&D function as well as the rest of the functions of the Indian subsidiary had no experience in developing and producing a product within such a short space of time. Finally they were able to deliver the product within 30 days. This has left them with greater confidence that they like to advertise, particularly to the headquarters and other German subsidiaries where such speed of development and delivery of such a product has never before been achieved.

In summary, the field research within all three subsidiaries reveals that access to specific external partners, especially to customers, has a significant impact on the way knowledge is created in the subsidiaries, and on the knowledge reversed to the headquarters.

In the case of the Philippine subsidiary, the access to specific external partners, e.g. former colleagues, has further been proved to have a strong influence on the ability of the software engineers to solve problems within their local projects, and to be able to reverse this knowledge to the headquarters.

5.2.4.7.2 Research question 7: discussion

The main aspect of the results, explored in respect of this seventh research question, is that the external environment of the subsidiary has a significant impact on the way knowledge is created within the subsidiary and also, importantly, reversed to the headquarters. Particularly in the case of the latter relationship, the significant impact of the external environment on the nature of the knowledge that a subsidiary reverses to the headquarters, has not yet been discussed in the contemporary literature. Taking a broader perspective, this relationship may be linked to the ambidexterity perspective, which suggests that a firm must explore as well as exploit knowledge that is located within, as well as outside of, itself (Rothaermel & Alexandre, 2009). The case study MNC juggles this form of knowledge creation through its subsidiaries along with the access to particular external environments that they develop.

5.2.4.8 Why do the employees of a particular subsidiary regard their subsidiary as offering a valuable knowledge base to the headquarters besides the influence of its external environment?

5.2.4.8.1 Research question 8: results

- **The Philippine subsidiary**

From the perspective of the interviewees of the Philippine subsidiary, the subsidiary constitutes a valuable knowledge base to the overall business network because, over the years, national as well as foreign-headquartered MNCs have recognised that the Philippines constitute a location that produces many graduates from national universities with software engineering degrees. Interviewee 11 states:

"Well, I think that Manila is a really great place for multinational companies which want to establish software development abroad. The cost of labour is compared to many European as well as North American countries really low. Plus, here in the Philippines we have a lot of young graduates who are looking for international employers."

Studying IT-related subject areas has become even more popular with school leavers since the number of employers in the IT sector has increased over the years. Although, it is common in the Philippines that graduates leave their country for job offers from abroad, there is no problem of a substantial brain drain in the area of software engineering; in other areas e.g. medical care, the situation is different. Here, a problem of the brain drain has emerged over the years leading to a lack of experts to guarantee sufficient care nationally. Moreover, the field research identifies that the majority of interviewees of the Philippine subsidiary believe themselves to be valuable knowledge providers to the overall business network because the subsidiary is located in a sales market that increasingly becomes relevant to the MNC.

- **The US subsidiary**

From the perspective of all interviewees of the US subsidiary, the subsidiary is a valuable knowledge base to the overall business network, because it is located within the North American market and thus is close to the North American customers as well as suppliers. In this connection interviewee 18 pointed out:

"I guess when you want to grow as a European-based company you primarily look at the US and Asia."

Moreover, the interviewees regard their subsidiary as a valuable knowledge provider because it possesses key knowledge in the area of water analytics and electrochemistry. This knowledge was developed prior to the acquisition of the US subsidiary by the MNC, and is regarded to be attributed to the availability of experts in the required areas.

- **The Indian subsidiary**

From the perspective of all interviewees of the Indian subsidiary, the subsidiary is a valuable knowledge base to the overall business network because the subsidiary is located in the Indian market and is thus closely connected to the Indian customers and suppliers. Moreover, the interviewees regard their subsidiary as a valuable knowledge provider because of the large pool of experts available in the areas of electronics and software engineering who the firm can hire at a much lower cost in India compared to Germany.

In this respect, interviewee 20 mentioned:

"We do have excellent universities which have relatively high numbers of graduates. The company therefore has a lot of options to recruit experts here in India. Moreover, especially when comparing the cost of labour in India to that in Germany, it is obvious that India is in many ways more suitable for the company to establish activities.

I am well aware of the good education in Germany and the availability of experts in the field that the company is interested in, but still, you know, here in India we can do also a lot of activities at a much lower cost compared to Germany."

In summary, the field research identifies that the interviewees of all three subsidiaries regard their subsidiaries as valuable knowledge bases for the overall MNC because the subsidiaries are located in the sales markets that the MNC intends to serve. All interviewees further suggest that the subsidiaries are regarded as constituting valuable knowledge bases because they are located in economies where the education system offers a large pool of experts in the areas where the MNC has an interest.

5.2.4.8.2 Research question 8: discussion

The main aspect of the results of the case study reveals, in respect of this eighth research question, that although the research question endeavoured to explore factors besides the external environment that lead employees of a subsidiary to think of the subsidiary as a valuable knowledge base to the overall MNC, the external partners still seem to be the main drivers for the employees to think of their subsidiaries as valuable knowledge bases. The market in which the various subsidiaries are embedded are regarded as one main factor why the subsidiaries are identified as valuable knowledge bases. It is the closeness to their customers (all subsidiaries) and suppliers (the US and Indian subsidiaries) that enables them to share knowledge and create the market knowledge that they reverse to the headquarters. In

a nutshell, this result supports the resource-dependency perspective as, for instance, applied by Fredericks (2005), in the way that the headquarters accesses important market knowledge that may be regarded as one resource of the MNC through its subsidiaries. Together with the internal existing knowledge base of the MNC, this resource is a key ingredient when developing new products and maintaining its competitive advantage.

In addition to the market, the availability of experts within the economies in which the subsidiaries are embedded, is regarded as a further factor why the employees of the subsidiaries recognise their subsidiaries as valuable knowledge bases to the overall MNC.

All in all, both factors that lead the employees of the subsidiaries to regard their subsidiaries as valuable knowledge bases, reflect the different theoretical approaches of the impact of the local embeddedness on knowledge creation in the firm that were reviewed in chapter two. Here, the field research explores the existing theories by focusing on the subsidiary, either being located in a developed, or an emerging, economy.

Moreover, both factors also support what has been found at headquarters´ level. Here, one key theoretical insight deals with the impact of economic dynamics on knowledge creation in the context of the MNC. The nature of these economic dynamics may be associated with the impact of the external environment on knowledge creation as it has been defined by the three subsidiaries. The concluding chapter will combine the theoretical insights emerging from both levels of analysis in a model.

To sum up, SECTION III presented and discussed the differences in the external environments of the subsidiaries. In this respect, it was identified that an external environment can potentially constitute a medium for knowledge loss. Moreover, the section discussed that the access to a particular external environment does not only have an impact on the process of knowledge creation at subsidiary level, but also on the knowledge that a

particular subsidiary reverses to the headquarters. Subsequently, it was identified that the external environment along with the availability of experts in the respective economies, are the main factors why subsidiaries regard themselves as offering a valuable knowledge base to the headquarters.

In conclusion, this chapter presented the results of the case study carried out as part of this thesis. The chapter is mainly composed of two parts that reflect the two levels of analysis adopted within the case study. PART I discussed the results with regard to the sub case study carried out at headquarters level in Germany, PART II recapitulatorily discussed the results in respect of the sub case studies conducted at subsidiary level in the Philippines, in the USA and in India. Altogether three theoretical insights were presented. In particular, the chapter demonstrated how the theoretical insights are grounded in the data which was collected. Finally, it was presented in what way the case study generated further important aspects which explore the main research question of this thesis in depth.

.

6. CONCLUSION

The thesis has revealed why it was important to explore several themes related to the broad subject of KM. In this respect, the thesis has particularly identified that the importance of KM, although it has existed for some time, remains significant for academics as well as practitioners, and also offers a number of further facets that have not been practically or theoretically explored. The case study carried out in this MNC provided several exciting new aspects and theoretical insights that have not been discussed in such a context in contemporary literature. This last chapter has two important aims. First of all, it discusses how the objectives of the thesis have been met. Secondly, it identifies the limitations of the thesis as well as presenting ideas for future research.

6.1 How has the objective of the thesis been met?

Chapter one provided four boxes that touched on the relevant aspects of KM that had been identified for detailed exploration within the thesis. Moreover, chapter one highlighted distinct gaps in the contemporary literature in respect of these aspects. The subsequent paragraphs briefly review how the case study explored these aspects as well as which theoretical insights could be generated.

6.1.1 The importance of knowledge at firm level

In box 1 of chapter one, it was stated that the literature identifies knowledge as a resource that plays a central role in the management of the firm because it is regarded as a major determinant of the firm's innovative capacity and its related performance and behaviour. Moreover, subsequent parts highlighted how and where firms create their knowledge has not yet been systematically explored and that this observation applies particularly to MNCs that are not large.

The thesis explored the creation of knowledge and knowledge sharing in the context of a German-headquartered MNC, its headquarters, and four of its geographically dispersed subsidiaries. The case study has shed light on knowledge creation as well as knowledge sharing amongst the various parties and provided the following key findings: the MNC organises most of its knowledge creation, protection and knowledge sharing processes by implementing a ´technology differentiation´ approach. The ´technology differentiation´ approach ensures that some of the key competencies that the MNC holds are spread amongst its subsidiaries. By the same token, the case study revealed that the subsidiaries are never in a position where they might gain the sum of knowledge that is needed in order to develop and produce an entire product. The link between the ´technology differentiation´ approach, and the management of reverse knowledge flows from subsidiaries, constitutes a key theoretical insight that has not yet been identified in the literature.

In particular, the ´technology differentiation´ approach represents one way how an MNC protects its key knowledge. Chapter one identified that research in respect of how a firm might protect its resource knowledge effectively is still in its infancy. The case study indicates that, although the MNC faces knowledge loss that can potentially lead to product piracy, the headquarters management is well aware that potential loss of knowledge does not

constitute a reason for abandoning knowledge sharing with its subsidiaries, or not strengthening their ability to create their own key knowledge. In this respect, an exciting aspect emerging from the case study is that the MNC focuses on knowledge creation in its subsidiaries, and knowledge sharing between the subsidiaries and the headquarters, as a result of the developments within its subsidiaries. Particularly with respect to its Chinese and Indian subsidiaries, the set-up of the subsidiaries was not associated with access to any particular knowledge, or the opportunity to create senders of knowledge in these economies. In contrast, first and foremost their set-ups resulted from bypassing strict policies and tariffs that China and India imposed on imported products.

Specifically, one practical implication that emerges from the case study is that MNCs headquartered in a developed economy must find a balance between protecting their key knowledge, whilst at the same time, integrating knowledge that is created at subsidiary level in emerging economies.

6.1.2 Reverse knowledge flows in the MNC

In box 2 of chapter one, it was stated that most of the existing literature on knowledge flows within the boundaries of the MNC has focused on forward knowledge flows that are sent from the headquarters to its subsidiaries. It was the aim of the thesis to explore the opposite direction of knowledge flows, reverse knowledge flows, which are sent from the subsidiaries to the headquarters. The case study provided several aspects of the different types along with the nature of the different types of knowledge that subsidiaries reverse to their headquarters. In this respect, the case study was particularly valuable because it revealed new facets of how subsidiaries that are located in different economies, both developed and emerging economies, differ in the type and nature of the knowledge that they reverse to the headquarters.

To briefly touch on the key aspects of the results:

- The results indicate that what was unexpected by the headquarters was the relatively short time that the Indian subsidiary took to transform from a knowledge recipient to a sender of knowledge to the headquarters. This aspect is valuable, because the ability of subsidiaries that are located in emerging economies to constitute a valuable knowledge source as well as knowledge sender to the MNC is limited.
- Furthermore, a valuable aspect of the case study is based on the result that differences in the nature of reverse knowledge flows that subsidiaries send to the headquarters can be related to the key competencies that the subsidiaries possess.
- The results indicate that the main obstacle that the headquarters management faces when managing and exploiting knowledge relates to knowledge loss that may lead to product piracy.

The main theoretical insight emerging from the results is that the high dynamics in emerging economies forces the MNC to set up production and R&D functions; the latter because only R&D employees who are located on the ground in the dynamic economies understand these dynamics and are able to respond to them in contrast to R&D employees who are located in an economy with less dynamics. The key practical implication of this theoretical insight is that in order to successfully compete in emerging markets, MNCs, which are headquartered in a developed economy such as Germany, must possess and strengthen certain R&D activity locally in emerging economies.

6.1.3 Subsidiaries and their external environments

Box 3 revealed that the literature increasingly studies subsidiaries as knowledge senders rather than knowledge recipients. In this respect, it was acknowledged that subsidiaries increasingly have an impact on the MNC to gain an overall competitive advantage. However,

box 3 also highlighted how subsidiaries create their knowledge and share it with the MNC needs an improved conceptualisation. A number of valuable aspects on knowledge creation and knowledge sharing within the subsidiary emerged from the case study. For instance, the case study suggests that the external environments that the subsidiaries develop not only have an impact on the knowledge creation within the subsidiaries, but also on the knowledge that the subsidiaries reverse to the headquarters.

Furthermore, the case study generates the theoretical insight that the senior local management at the subsidiaries play a key role in motivating their employees to create new knowledge bases and learning capabilities and to discuss drivers of this motivation with the headquarters. The case study further indicates that the headquarters management is often perceived as hindering the senior local management to allow for sufficient training and knowledge creation among its employees. Potentially, this result might have the following implication for the headquarters´ management: Enabling more effective knowledge creation within its foreign subsidiaries, the headquarters´ management must find a way to incorporate any suggestions made by the senior local managers of its subsidiaries whilst also leaving them with more autonomy to decide how knowledge creation is best organised locally.

6.1.4 The MNC and the sector of mechatronics

The final box, box 4, of chapter one identified that most of the studies related to KM in the context of the MNC focus on large MNCs. Moreover, it pointed to the sector of mechatronics in which studies of the subject area have yet to be carried out.

The case study of the thesis examined how the MNC, which is not a large MNC, organises KM with special focus on its management and exploitation of reverse knowledge flows sent from subsidiaries to the headquarters. The case study presented its ´technology differentiation´ approach that is one principal strategy of the MNC to react to increasing

worldwide competitive pressures. Although the MNC is not large, it has production and R&D functions in most of the main growth markets that it intends to serve. Local presence is important to allow for cost-effective product adaptations and customer contact as well as innovative input from its subsidiaries.

The sector of mechatronics constituted a valuable research setting to explore the main research question. The ´technology differentiation´ approach can only be adopted by the MNC because of the nature of mechatronics and mechatronical products, which were reviewed in detail in chapter four of this thesis. It is the opportunity to split mechatronical products into different elements and distinct technological areas that allows the MNC to adopt its ´technology differentiation´ approach. Accordingly, ´technology differentiation´ may only be implemented by distinct sectors that focus on products that integrate different elements that can be developed and produced individually. From a managerial perspective, a split of technologies into different areas that are then developed among different R&D units spreads across the globe, and is challenging for a number of reasons. In this context, the case study highlighted, for instance, that lack of willingness to share knowledge at headquarter´s level as well as different approaches towards product design among R&D units can make the timely integration of knowledge and technologies difficult. While the effective integration of knowledge seems to be a challenge that primarily concerns the management at headquarter's level, there is another specific situation related to the ´technology differentiation´ approach which constitutes a potential obstacle for the management at subsidiary level. The case study identified the frustration of employees at subsidiary level who are primarily concerned with the technological development of specific parts of products. In particular, the case study points to the Indian and Philippine employees who associated the development of fully functioning products with a lack of trust of the headquarters' management in the

competencies at subsidiary level. One implication of this association for the management at subsidiary level seems to be that it tries to compensate its employees for not being fully involved in product development by offering them training in a variety of work-related fields.

6.1.5 The combined contribution of the theoretical insights

The model below visually combines three theoretical insights that emerged from the case study and concentrates the theoretical contribution of the thesis.

At the centre, there is the relatively large knowledge base of the headquarters. It combines several elements that are demonstrated by the varying grey shading. In particular, this knowledge base also exists of knowledge that is reversed by various subsidiaries. These relatively small subsidiary knowledge bases are represented by the four smaller, geometrically-shaped elements that are connected through hyphenated arrows with the knowledge pool at headquarters´ level. The knowledge that the subsidiaries reverse to the headquarters is strongly influenced by: a) the dynamics of the economies in which the particular subsidiaries are embedded, these are symbolised by the grey-shaded, large arrows; and b) by the senior local management who is symbolised by the smiley character within the different knowledge elements.

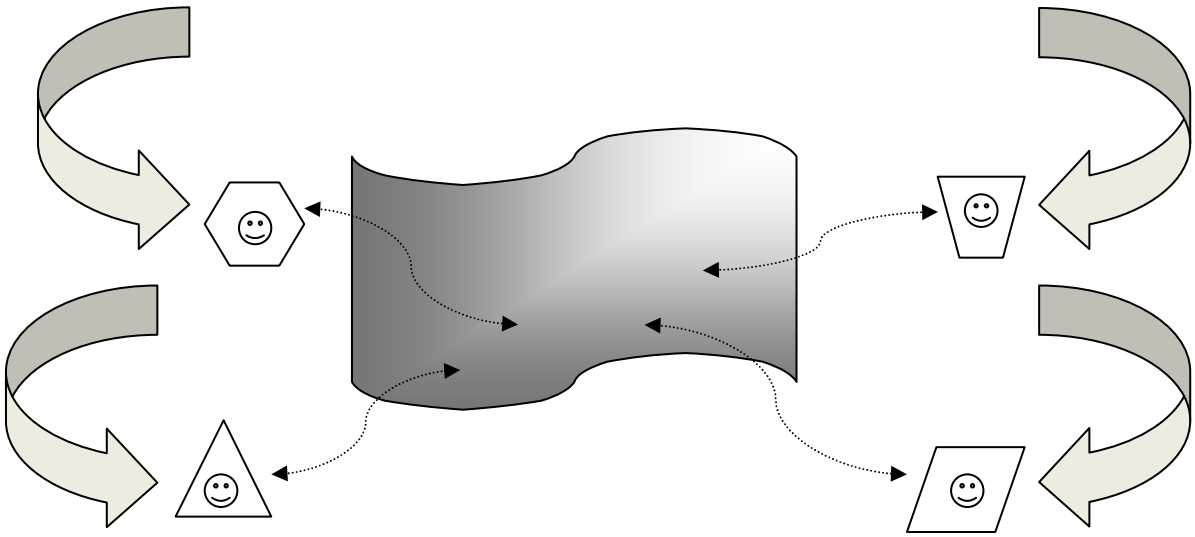

Figure 2: Managing knowledge flows within and across the boundaries of the MNC

6.2 Limitations of the thesis and ideas for future research

The main limitation of the thesis is that it relies on a case study of one single firm. The comparison of the current results to those emerging from research in related firms (e.g. similar sized or industry of the present case firm) will be a rich supplement to the thesis and will substantially contribute to knowledge of the subject area. In detail, chapter three reviewed that the dominant criticism in respect of the case study research strategy is that its related results would hardly build the basis for generalisation.

However, the case study, which was from the beginning defined as having an exploratory nature, revealed a number of exciting new aspects that could, to some extent, be transformed into theoretical insights.

The paragraphs above summarised three theoretical insights. To give them appropriate scientific strength, they must be tested in many research settings. In this context, future research should also draw on different research strategies and methods than those employed in this thesis.

Another limitation of the thesis deals with the specific relationship between the researcher and the company studied here. Chapter three explains this relationship in detail and explores the way in which the attributes of the relationship might influence the research carried out. The key challenge deals with the question of how the case study might demonstrate that the collected data is reliable. In this research context, reliability primarily means that the researcher ensures that the interviewees do not respond with what they think the research needs to hear. One practical approach taken to overcome this challenge was the split of the single firm case study into four case studies carried out in four different locations. Moreover, the reliability of the research was strengthened by a constant comparison of the

concepts that developed from the data collected at headquarters' level with the data collected at subsidiary level.

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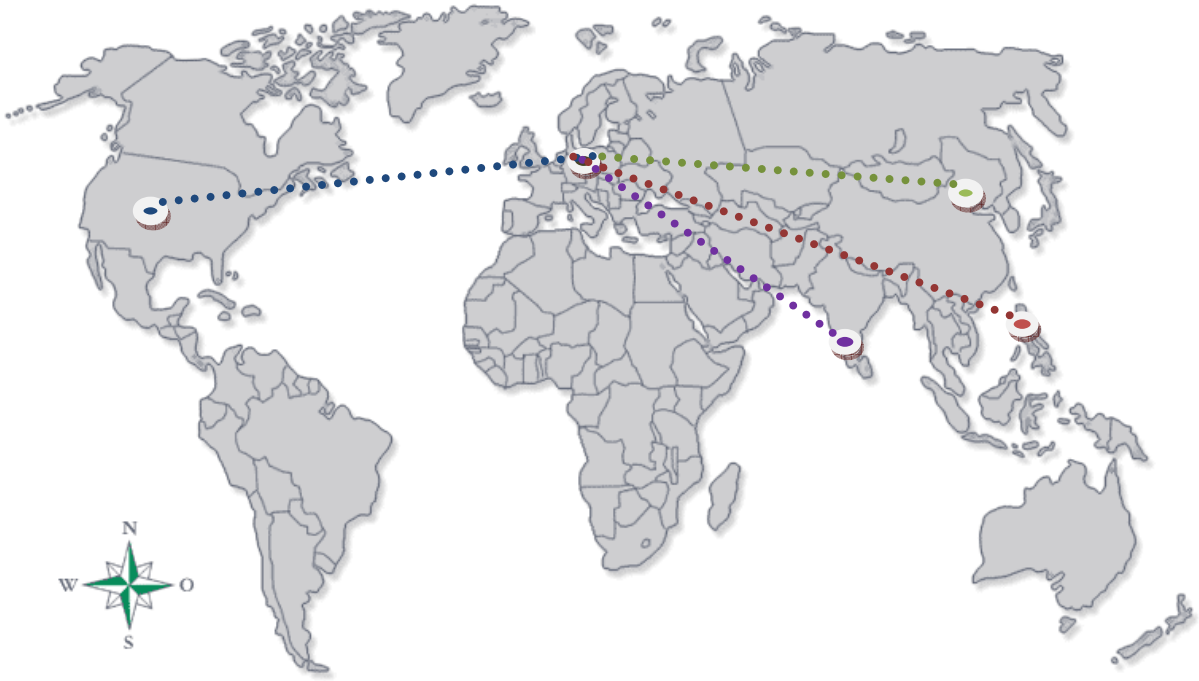
APPENDIX I

INTERNATIONAL KNOWLEDGE FLOWS - ANALYSIS



APPENDIX II
INTERVIEW GUIDE HEADQUARTERS LEVEL

Ganz allgemein betrachtet, fließt aus Ihrer Sicht Wissen von den ausländischen Tochtergesellschaften zurück an die Muttergesellschaft in Deutschland?

Wenn ja, in welchen Bereichen wird Wissen von den ausländischen Tochtergesellschaften an die Muttergesellschaft gesendet?

Wie unterscheiden sich die einzelnen Tochtergesellschaften in der Form des Wissens, welches sie an die Muttergesellschaft senden?

Inwieweit wurden Tochtergesellschaften angesiedelt, um Sender von Wissen im Bezug auf die Muttergesellschaft zu schaffen bzw. Akquisitionen durchgeführt, um Wissen in das Muttergesellschaft zu holen?

Wie werden Wissensflüsse, welche von den ausländischen Tochtergesellschaften an die Muttergesellschaft zurückfließen, organisiert und gemanagt?

Gibt es Hindernisse bzw. Probleme, die für die Muttergesellschaft entstehen wenn Wissen von den ausländischen Tochtergesellschaften beschafft bzw. genutzt wird?

Wenn ja, bitte benennen Sie welche Hindernisse bzw. Probleme die Muttergesellschaft bei der Beschaffung und Nutzung von Wissen durch die ausländischen Tochtergesellschaften entstehen.

APPENDIX III
INTERVIEW GUIDE SUBSIDIARY LEVEL

Do you regard the headquarters as interested in your knowledge base?

If yes, when exactly or why do you regard the headquarters as interested in your knowledge base?

In what way do you feel motivated by the headquarters to develop new knowledge bases and learning capabilities?

Could you give some concrete example in respect of what motivates you to develop new knowledge bases and learning capabilities and how the headquarters is helping you to develop new knowledge bases and learning capabilities.

Do you face obstacles when you share knowledge with the headquarters? If yes, could you please give some concrete examples.

Under what conditions are you willing to reverse your key knowledge to the headquarters?

Do you regard knowledge sharing also as a risk to lose your own key knowledge?

What do you expect from the headquarters when you reverse your key knowledge?

What are potential risks that you might face when you reverse your key knowledge to the headquarters?

In what way do you face risks when you reverse your key knowledge to the headquarters?

Who are your external partners?

How do your external partners influence you when you are creating new knowledge?

Do your external partners have an impact on the knowledge that you reverse to the headquarters?

Taking a rather general view, why do you think that your subsidiary offers a valuable knowledge base to the headquarters?